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Prepared for:



**Crab Orchard National Wildlife Refuge
Marion, Illinois**

Report on:

**Phase I
Remedial Investigation of the
Miscellaneous Areas Operable Unit**

Volume I of II

December 1993

**Prepared by:
U.S. Army Corps of Engineers
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REPORT ON

**PHASE I REMEDIAL INVESTIGATION
MISCELLANEOUS AREAS OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS**

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EXECUTIVE SUMMARY

This report presents the results of Phase-I Remedial Investigations (RI) of the Miscellaneous Areas Operable Unit (Misc AOU) at the Crab Orchard Wildlife Refuge near Marion, Illinois. The Phase-I RI was authorized by Contract No. DACW45-92-D-7 and conducted in compliance with Section 7.2 of the Federal Facilities Agreement (FFA). The investigation was conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act (CERCLA/SARA), and the National Contingency Plan (NCP). The FFA includes 23 sites in the Misc AOU; no investigations were required at eight of these sites. The Phase-I RI included 15 Misc AOU sites and, one additional site, a post treating facility (Site 22A).

The objective of Phase-I Remedial Investigations was to gather the necessary chemical and ecological data to evaluate the need for any additional investigations so that the potential risk to human health and the environment could be evaluated.

Consistent with the Project Work Plans (USACE, 1993a, b, c & d), Phase-I activities for the sites included the following:

- preliminary site visits (consisting of visual examination) and a review of previous investigation results at Sites 21, 27 and 35;
- collection of 61 investigate samples (consisting of soil, sediment and sludge) from 13 sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, 22A and 36); and
- laboratory analyses of samples for Target Compound List (TCL) volatile organic compounds, TCL semivolatile organic compounds, TCL pesticides and polychlorinated biphenols, explosives, dioxins/furans (only at Site 22A) and Target Analyte List (TAL) inorganic parameters.

The major conclusions resulting from the Phase-I RI include the following:

- Sites 21, 27 and 35 did not warrant site sampling investigations based on previous investigative site history.
- Samples from Sites 7A, 12 and 20 contained concentrations below Preliminary Levels of Concern (PLCs) and/or Adjusted Preliminary Levels of Concern (APLCs) for all analytes.

- None of the samples from investigative sites had detectable concentrations of TAL cyanide, and only one sample (Site 11A) had detectable concentrations of the explosive compound TNT.
- Samples from Sites 7, 8, 9, 11, 14, 16 and 36 had concentrations of TAL metals at levels above their respective PLCs. At Sites 7, 8, 9, 11, and 14, the TAL metals which exceed PLCs are at levels near reported background concentrations.
- Samples from Sites 10, 14, 16, 22A and 36 had concentrations of select organic compounds (TCL VOCs, TCL SVOCs, TCL pesticides/PCBs or dioxins/furans) at levels above their respective PLCs/APLCs.
- Soil samples from Site 11A had detectable concentrations of an explosive compound (TNT) and a pesticide (heptachlor epoxide) for which PLCs/APLCs were not established.

Recommendations resulting from the Phase-I RI include the following:

- No additional investigations are recommended for Sites 7, 7A, 8, 9, 11, 11A, 12, 20, 21, 27 and 35.
- Additional RI site studies (Phase-II) are warranted for Sites 10, 14, 16, 22A and 36.

TABLE OF CONTENTS

Volume I of II

Volume I	Report On: Phase-I Remedial Investigation of the Misc AOU
	Appendix A
	Appendix B
	Appendix C
Volume II	Appendix D

Executive Summary	-i-
Table of Contents	-iii-
Commonly Used Acronyms and Abbreviations	-viii-

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION	1
1.1 Phase-I Investigation Objectives and Scope	2
1.2 Report Organization	3
1.3 Site Location	4
1.4 Site Background	4
1.5 Site Environmental Milestones	5
1.6 Previous Investigations	6
1.7 Site Histories and Results of Previous Investigations	7
1.7.1 D Area	7
1.7.1.1 Site 7 - D Area Southeast Drainage Channel	8
1.7.1.2 Site 7A - D Area North Lawn	8
1.7.1.3 Site 8 - D Area Southwest Drainage Channel	8
1.7.1.4 Site 20 - D Area South Drainage Channel	8
1.7.2 P Area	9
1.7.2.1 Site 9 - P Area Northwest Drainage Channel	9
1.7.2.2 Site 10 - P Area North Drainage Channel	9
1.7.2.3 Site 11 - P Area Southeast Drainage Channel	10
1.7.2.4 Site 11A - P Area Walkway Structures	10
1.7.3 Area 14	10
1.7.3.1 Site 12 - Area 14 Impoundment	10
1.7.3.2 Site 13 - Area 14 Change House	11
1.7.3.3 Site 14 - Area 14 Solvent Storage Drainage Ditch	12
1.7.4 Site 16- Area 7 Industrial Park	12
1.7.5 Site 18 - Area 13 Loading Platform	13
1.7.6 Site 21 - Area 7 Southeast Corner Field	13
1.7.7 Site 22A - Old Refuge Shop Area - Post Treating Facility ...	14
1.7.8 Site 24 - West Drainage Ditch	15
1.7.9 Site 25 - Marion Landfill	16
1.7.10 Site 26 - Marion Sewage Treatment Plant	16
1.7.11 Site 27 - Crab Orchard Creek Dredge Area	16
1.7.12 Site 30 - Area 13 Munitions Control Site	17
1.7.13 Site 31 - Refuge Control Site	17
1.7.14 Site 34 - Crab Orchard Lake	18
1.7.15 Site 35 - Area 9 East Waterway	18
1.7.16 Site 36 - Area 3 North Waste Water Treatment Plant	18

TABLE OF CONTENTS (continued)

2.0	INVESTIGATION METHODS AND PROCEDURES	20
2.1	Preliminary Site Visits	20
2.2	Collection of Analytical Samples	20
2.2.1	Sample Locations	21
2.2.1.1	Soils	22
2.2.1.2	Sediment and Sludge	22
2.2.2	Sample Collection Methods	23
2.2.2.1	Soils	23
2.2.2.2	Sediment and Sludge	25
2.2.3	Sample Shipment	27
2.3	Sampling Equipment Decontamination	27
2.4	Analytical Parameters	28
2.4.1	Volatile Organic Compounds	28
2.4.2	Semivolatile Organic Compounds	28
2.4.3	Organochlorine Pesticides and Polychlorinated Biphenyls ..	28
2.4.4	Explosives	29
2.4.5	Dioxins/Furans	29
2.4.6	Inorganics	29
3.0	PHYSICAL CHARACTERISTICS OF THE STUDY AREA	30
3.1	Climate	30
3.2	Surface Features	30
3.3	Surface Water Hydrology	30
3.4	Geology	31
3.4.1	Soils	31
3.4.2	Geology	32
3.4.3	Geochemistry	33
3.5	Hydrogeology	35
3.6	Water Resources	36
3.7	Demography and Land Use	36
3.8	Ecology	37
4.0	QUALITY CONTROL SUMMARY REPORT	38
5.0	INVESTIGATION RESULTS	39
5.1	Results of Preliminary Site Visits	39
5.2	Results of Sample Analyses	39
5.2.1	Preliminary Levels of Concern	40
5.2.2	Site 7 - D Area Southeast Drainage Channel	42
5.2.3	Site 7A - D Area North Lawn	43
5.2.4	Site 8 - D Area Southwest Drainage Channel	43
5.2.5	Site 9 - P Area Northwest Drainage Channel	43
5.2.6	Site 10 - P Area North Drainage Channel	44
5.2.7	Site 11 - P Area Southeast Drainage Channel	45
5.2.8	Site 11A - P Area Walkway Structures	46
5.2.9	Site 12 - Area 14 Impoundment	46
5.2.10	Site 14 - Area 14 Solvent Storage Drainage Ditch	47
5.2.11	Site 16 - Area 7 Industrial Park	48
5.2.12	Site 20 - D Area South Drainage Channel	49
5.2.13	Site 22A - Post Treating Facility	50
5.2.14	Site 36: Waste Water Treatment Plant	52

TABLE OF CONTENTS (continued)

	5.2.14.1	Site 36 - Dove Creek	52
	5.2.14.2	Site 36 - West Pond	54
	5.2.14.3	Site 36 - East Pond	54
	5.2.14.4	Site 36 - Primary Lagoon	56
5.3	Summary		57
6.0	CONTAMINANT FATE AND TRANSPORT		58
6.1	Nature and Extent of Contamination		58
	6.1.1 Site 7 - D Area Southeast Drainage Channel		58
	6.1.2 Site 8 - D Area Southwest Drainage Channel		59
	6.1.3 Site 9 - P Area Northwest Drainage Channel		59
	6.1.4 Site 10 - P Area North Drainage Channel		59
	6.1.5 Site 11 - P Area Southeast Drainage Channel		59
	6.1.6 Site 11A - P Area Walkway Structures		60
	6.1.7 Site 14 - Area 14 Solvent Storage Drainage Ditch		60
	6.1.8 Site 16 - Area 7 Industrial Park		60
6.2	Release Mechanisms and Potential Pathways		61
6.3	Physical Properties of Compounds		62
	6.3.1 Polychlorinated Biphenyls (PCBs)		63
	6.3.2 Semi-Volatile Organic Compounds (SVOCs)		64
	6.3.3 Dioxins/Furans		64
	6.3.4 Volatile Organic Compounds (VOCs)		65
	6.3.5 Inorganic Compounds		65
6.4	Pathways of Concern		66
	6.4.1 Site 7 - D Area Southeast Drainage Channel		66
	6.4.2 Site 8 - D Area Southwest Drainage Channel		66
	6.4.3 Site 9 - P Area Northwest Drainage Channel		66
	6.4.4 Site 10 - P Area North Drainage Channel		67
	6.4.5 Site 11 - P Area Southeast Drainage Channel		67
	6.4.6 Site 11A - P Area Walkway Structures		67
	6.4.7 Site 14 - Area 14 Solvent Storage Drainage Ditch		67
	6.4.8 Site 16 - Area 7 Industrial Park		67
	6.4.9 Site 22A - Post Treating Facility		67
	6.4.10 Site 36 - Waste Water Treatment Plant		67
7.0	SUMMARY, CONCLUSIONS AND RECOMMENDATIONS		70
	7.1 D Area Sites 7 and 8		70
	7.2 D Area Site 7A		71
	7.3 Sites 13, 18, 21, 27 and 35		71
	7.4 P Area Sites 9, 11 and 11A, D Area Site 20 and Area 14 Site 12		71
	7.5 Site 10 P - Area North Drainage Channel		72
	7.6 Site 14 - Area 14 Solvent Storage Drainage Ditch		73
	7.7 Site 16 - Area 7 Industrial Park		74
	7.8 Site 22A - Post Treating Facility		74
	7.9 Site 36 - Waste Water Treatment Plant		75
	REFERENCES		79

TABLE OF CONTENTS (continued)

TABLES

Table 1	Phase-I RI Activities, Miscellaneous Areas Operable Unit
Table 2	Sampling Activities
Table 3	Field Descriptions of Samples
Table 4	Quantitation Limits for Target Compound List VOCs in Soil, Sediment and Sludge
Table 5	Quantitation Limits for Target Compound List SVOCs in Soil, Sediment and Sludge
Table 6	Quantitation Limits for Target Compound List PCBs and Pesticides in Soil, Sediment and Sludge
Table 7	Reporting Limits for Explosives in Soils, Sediments and Sludge
Table 8	Reporting Limit for Dioxins and Furans in Soil, Sediment and Sludge
Table 9	Detection and Quantitation Limits for Target Analyte List Metals and Cyanide in Soil, Sediment and Sludge
Table 10	Summary of Validated TCL Volatile Organic Compound Analyses of Soil, Sediment and Sludge Samples
Table 11	Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment and Sludge Samples
Table 12	Summary of Validated TCL Organochlorine Pesticide and PCB Analyses of Soil, Sediment and Sludge Samples
Table 13	Summary of Validated Explosive Compound Analyses of Soil, Sediment and Sludge Samples
Table 14	Summary of Validated Dioxins/Furans Analyses of Soil Samples
Table 15	Summary of Validated TAL Inorganic Analyses of Soil, Sediment, and Sludge Samples
Table 16	Preliminary Levels of Concern and Adjusted Preliminary Level of Concern for Organic Compounds
Table 17	Preliminary Levels of Concern and Adjusted Preliminary Level of Concern for Detected Inorganic Analytes
Table 18	Summary of Constituents Detected during 1993 Phase-I Investigation
Table 19	Primary Media Potentially Impacted by Release of Compounds of Concern
Table 20	Indicator Scores
Table 21	Physical Properties of Indicator Compounds

FIGURES

Figure 1	Refuge Location Map
Figure 2	Miscellaneous Areas Operable Unit Crab Orchard National Wildlife Refuge
Figure 3	Areas/Features for Sites Located North of Crab Orchard Lake
Figure 4	Areas/Features for Sites Located South of Crab Orchard Lake
Figure 5	Sites 7, 7A, and 8 Phase-I Sample Locations
Figure 6	Site 20 Phase-I Sample Locations
Figure 7	Sites 9, 10 and 11 Phase-I Sample Locations
Figure 8	Site 11A Phase-I Sample Locations
Figure 9	Site 12 Phase-I Sample Locations
Figure 10	Site 14 Phase-I Sample Locations
Figure 11	Site 16 Phase-I Sample Locations

TABLE OF CONTENTS (continued)

Figure 12	1960 Aerial Photograph Showing Post Treating Facility Features
Figure 13	Post Treating Facility (Site 22A) Phase-I Sample Locations
Figure 14	Site 36 Phase-I Sample Locations
Figure 15	Sites 9, 10, and 11 Summary of Analytical Results
Figure 16	Site 11A Summary of Analytical Results
Figure 17	Site 14 Summary of Analytical Results
Figure 18	Site 16 Summary of Analytical Results
Figure 19	Post Treating Facility (Site 22A) Summary of Analytical Results
Figure 20	Site 36 Summary of Analytical Results

APPENDICES

Appendix A	Responses to Agency Comments on the August 1993 Draft Report on the Phase-I RI of the Misc AOU
Appendix B	Background Data Base for Metals in Soils
Appendix C	Preliminary Risk-Based Screening Calculations
Appendix D	Preliminary Ecological Risk Assessment

COMMONLY USED
ACRONYMS AND ABBREVIATIONS

APLC	Adjusted Preliminary Level of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	Chain of Custody
⁰ C	degrees Celsius
DA	Department of the Army
DI	Deionized
DOD	Department of Defense
DOI	Department of Interior
DQCR	Daily Quality Control Reports
DQCSR	Daily Quality Control Summary Reports
DQO	Data Quality Objective
EMMA OU	Explosives/Munitions Manufacturing Areas Operable Unit
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	Feasibility Study
FWS	U.S. Fish and Wildlife Service
HPLC	High Performance Liquid Chromatography
HQ	Hazard Quotient
ICR	Incremental Cancer Risk
IEPA	Illinois Environmental Protection Agency
IOP	Illinois Ordnance Plant
LCS	Laboratory Control Sample
LUST	Leaking Underground Storage Tank
MA OU	Metals Area Operable Unit
MCL	Maximum Contamination Level
MDL	Methods Detection Limit
Misc AOU	Miscellaneous Areas Operable Unit
MRD	Missouri River Division
MRL	Method Reporting Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NCP	National Contingency Plan
NDMA	N-nitrosodimethylamine
NPL	National Priorities List
NWR	National Wildlife Refuge
OC	Organochlorine
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PLC	Preliminary Levels of Concern
PRP	Potentially Responsible Party
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCSR	Quality Control Summary Report
RfDs	Reference Doses
RI	Remedial Investigation
ROD	Record of Decision
RPD	Relative Percent Difference

COMMONLY USED
ACRONYMS AND ABBREVIATIONS (cont'd)

SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SF	Slope Factor
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TNT	2,4,6-trinitrotoluene
TOX	Total Organic Halides
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
EPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

This report presents the findings of Phase-I Remedial Investigations (RI) of the Miscellaneous Areas Operable Unit (Misc AOU) at the Crab Orchard National Wildlife Refuge (the Refuge) located near Marion, Illinois (Figure 1). The Phase-I RI was conducted pursuant to the Federal Facility Agreement (FFA), dated September 13, 1991, that was negotiated among the United States Environmental Protection Agency (EPA), the Illinois Environmental Protection Agency (IEPA), the Department of the Interior (DOI), and the Department of the Army (DA). The Phase-I RI was also conducted in compliance with Section 7.2 of the FFA, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act (CERCLA/SARA), and in accordance with the National Contingency Plan (NCP).

The FFA requires that the DOI perform a RI of the Misc AOU. A scope of services was prepared by the U.S. Army Corps of Engineers (USACE) as a basis for the Phase-I Project Work Plan (USACE, 1992). The Project Work Plans included the following:

- Work Plan (USACE, 1993a)
- Sampling and Analysis Plan (USACE, 1993b)
- Health and Safety Plan (USACE, 1993c)
- Quality Assurance Project Plan (USACE, 1993d)

The Project Work Plans were reviewed and approved by the EPA and the IEPA.

The FFA includes 23 sites in the Misc AOU: Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 13, 14, 16, 18, 20, 21, 24, 25, 26, 27, 30, 31, 34, 35 and the wastewater treatment plant and downstream areas (Site 36). The Misc AOU sites are listed in Table 1 and are shown on Figure 2.

The FFA does not mention the Post Treating Facility (designated Site 22A). The site is, however, included in the Scope of Services provided to Montgomery Watson/Golder Associates by the USACE/DOI (USACE, 1992), as part of the Misc AOU RI. The site number (22A) was assigned, with prior approval from DOI, during preparation of the

Project Work Plans. The DOI will formally request that Site 22A be added to the Misc AOU.

This report incorporates comments provided by the USEPA, IEPA, and the FWS on the Draft Phase-I RI Report for the Misc AOU, dated August 24, 1993 (USACE 1993e). A copy of responses to Agency comments are provided in Appendix A for reference.

1.1 Phase-I Investigation Objectives and Scope

The objective of Phase-I Remedial Investigations was to gather the necessary chemical and ecological data to evaluate the need for any additional investigations so that the potential risk to human health, wildlife, and the environment could be evaluated at the following areas:

- Areas where it is believed that previous site operations resulted in releases of chemicals to the ground. These areas are designated as Misc AOU Sites 7A, 12 and 22A. Portions of Misc AOU Sites 11A and 16 also contain areas of potential chemical releases to the ground.
- Sludge deposits in the primary lagoon and two ponds at Site 36.
- Areas where contaminants may have been transported by surface runoff from active and abandoned industrial facilities to nearby drainage ways and streams. The drainage ways and streams are designated as Misc AOU Sites 7, 8, 9, 10, 11, 14 and 20. Portions of Misc AOU Sites 11A, 16 and 36 also include drainage ways or streams. These drainage ways and streams discharge to Crab Orchard Lake.

Consistent with the Project Work Plans (USACE, 1993a, b, c & d), Phase-I activities included the following:

- No further RI activities were required at Sites 13, 18 and 34.
- Preliminary site visits, consisting of visual examination, at Sites 21, 27 and 35.
- Collection of soil, sediment and sludge samples at 13 sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, 22A and 36).

The Project Work Plans required the collection and chemical analysis of 61 investigative samples, including 48 soil samples, 8 sediment samples, 5 sludge samples, and an additional number of Quality Assurance and Quality control (QA/QC) samples. During the investigation, 62 investigative samples were actually collected. The analytical program included the target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), TCL pesticides and polychlorinated biphenyls (PCBs); explosives; and, target analyte list (TAL) metals and cyanides. Samples from Site 22A were also analyzed for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (dioxins/furans). Table 2 summarizes, for each site, the sample collection activities and required analyses. A Quality Control Summary Report of Phase-I analytical results was issued by USACE (1993f) in September 1993.

In the period since the Project Work Plans were prepared and approved, the U.S. Fish and Wildlife Service (FWS) requested that Phase-I ecological assessments be conducted at the sites investigated as part of the Phase-I RI (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 13, 14, 16, 18, 20, 21, 22A 27, 35 and 36), with the exception of Crab Orchard Lake (Site 34), to provide additional data for a baseline risk assessment. The ecological assessments are being performed in accordance with EPA Region V "Regional Guidance for Conducting Ecological Assessments" (USEPA, undated) provided to the USACE by the EPA on April 6, 1993. Preliminary ecological assessments have been completed and are described in the "Preliminary Ecological Risk Assessment" Report (Volume II of II).

1.2 Report Organization

The text of this Phase-I RI Report is divided into seven sections, including this Introduction, Section 1.0. The remainder of Section 1.0 presents an overview of site location and background, environmental milestones, site history and previous investigations. The following describes the remaining sections and their contents:

- Section 2.0 describes the methods and procedures used for the investigation.
- Section 3.0 describes the physical characteristics of the Refuge and sites.
- Section 4.0 presents a summary of the Quality Control Summary Report

- Section 5.0 presents the results of the Phase-I investigation and pertinent results from other investigations.
- Section 6.0 presents a discussion of the fate and transport of compounds of concern.
- Section 7.0 presents a summary of the results, conclusions, and preliminary recommendations for Phase-II work.

1.3 Site Location

The Refuge consists of 43,500 acres located in southern Illinois near the cities of Marion, Carterville and Carbondale. The Refuge is located primarily within Williamson County with portions extending into neighboring Jackson and Union Counties. The location and boundaries of the Refuge are identified on Figure 1. All of the Misc AOU sites are located in Williamson County. Site names and numbers are provided in Table 1, and their respective locations are depicted on Figure 2.

1.4 Site Background

The Refuge is owned by the United States Government and is currently administered by the FWS, a bureau of the Department of the Interior (DOI). The Refuge was previously administered by the Department of Defense (DOD).

Congress, in passing the law that created the Crab Orchard National Wildlife Refuge, mandated that the lands be utilized in a manner consistent with the needs of industry, as well as those of agriculture, recreation, and wildlife conservation. Congress viewed the industrial activities at the Refuge as one of its four purposes.

During the DOD administration, portions of the Refuge, known then as the Illinois Ordnance Plant (IOP), were leased to industrial tenants primarily for purposes of manufacturing munitions and explosives. The IOP began operation in June of 1942. In 1947, the DOD transferred the IOP to the DOI. Production of explosives continued to be the principal industry on the Refuge, but other industries moved onto the sites to occupy buildings formerly used by wartime industries. The new tenants included industries that manufactured transformers and capacitors containing PCBs, automobile parts, fiberglass

boats, corrugated boxes, plated metal parts, tape, flares and jet engine starters. Manufacturing activities continue at several locations in the closed portion of the Refuge.

1.5 Site Environmental Milestones

The EPA proposed the Refuge for inclusion on the National Priorities List (NPL) in 1984, and formally listed the Refuge on the NPL in July 1987. In February of 1986, the FWS and EPA entered into a Federal Facility Initial Compliance Agreement which required the implementation of Remedial Investigation/Feasibility Study (RI/FS) activities at 33 potentially contaminated sites, and two background sites. The RI/FS began in 1986 (O'Brien and Gere, 1988). A draft RI Report was submitted in 1988 which provided specific recommendations for each site: feasibility studies were to be prepared for seven sites, four sites were retained for further evaluation by DOD, eight sites were to undergo periodic monitoring, and fourteen sites were eliminated from further evaluation or action. A feasibility study was completed on the recommended sites in 1989.

Upon completion of the draft FS report, the EPA designated sites contaminated primarily with metals as the Metals Operable Unit, and other sites contaminated with primarily PCBs as the PCB Areas Operable Unit. The EPA signed a Record of Decision (ROD) for the Metals Areas Operable Unit on March 30, 1990, and a ROD for the PCB Areas Operable Unit on August 1, 1990. Remedial action and remedial design (RA/RD) activities are presently underway at these operable units.

In August and September of 1991, the EPA, DOI, Department of the Army, and IEPA signed a Federal Facilities Agreement (FFA). The FFA recognized two additional operable units: 1) areas associated with Explosive and Munitions Manufacturing Areas (EMMAOU, 14 sites) and, 2) miscellaneous areas (Misc AOU 23 sites) that in the 1988 RI Report were recommended as needing further investigation, monitoring or maintenance, or not requiring any further work (O'Brien and Gere, 1988). The FFA required, among other items and activities, that the DOI perform RI investigations for the Misc AOU.

1.6 Previous Investigations

All of the sites, which are the subject of this RI (except for Sites 22A and 36), were previously investigated as part of an RI completed for the FWS and Sangamo Weston, Inc. by O'Brien and Gere Engineers of Syracuse, New York in 1988.

Investigations at Site 22A were conducted by the FWS in 1989 and 1990. The investigations consisted of the collection of five soil samples that were analyzed for aromatic hydrocarbons in 1989 (Texas A&M University, 1989) and cadmium in 1990 (Hazelton Laboratories America, 1990). No report was prepared. The investigation results are described in Section 5.2.

Investigations at Site 36 (Wastewater Treatment Plant) were conducted by the FWS in 1988. Five sediment samples were collected from drain ways east and southeast of the facility and were analyzed for pesticides and PCBs (Texas A&M University, 1989). Prior to 1988, investigations of the Wastewater Treatment Plant (WWTP) were limited to samples collected from single locations downstream of the facility that were analyzed for PCBs. The investigation results are described in Section 5.2.

The RI completed in 1988 included 33 sites located within the eastern portion of the Refuge (O'Brien and Gere, 1988). Field work was performed in two phases and included geophysical surveys, hydrogeological investigations, collection of soil, sediment, surface water, groundwater and fish samples for chemical analysis. The objective was to define the nature and extent of contamination and the potential for migration. The results of previous investigations and historical information were used, whenever possible, as a basis for establishing analytical parameters; otherwise broad analytical scans for organic and inorganic compounds were used in the analyses. The RI included an assessment of the potential impacts from the contaminants to human health, wildlife and the environment. Previous investigation results are summarized in site descriptions below and in Section 5.2.

Because of quality assurance/quality control (QA/QC) problems discovered with the laboratories performing analyses for the previous RI, many of the analytical results are not useable, or are useable with qualifications (O'Brien and Gere, 1988, Exhibit B). Results

from the previous RI that are usable are presented in this report, where appropriate, to supplement the Phase I RI data.

1.7 Site Histories and the Results of Previous Investigations

Of the 24 sites that are addressed in this RI (as described in the Project Work Plans), preliminary site visits were conducted at 3 sites (Sites 21, 27 and 35) and sampling/analysis was conducted at 13 sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, and 36). No RI activities were completed or are planned at eight Misc AOU Sites (13, 18, 24, 25, 26, 30, 31 or 34) because of the following reasons:

- 1) the previous RI determined that Sites 13, 18, 24, 25 and 26 present no exposure risk to human health, wildlife or the environment;
- 2) the FFA states that Sites 24, 25 and 26 require no additional work - these sites are outside the Refuge boundary and are not on DOI property (Figure 2);
- 3) Sites 30 and 31 are known to be removed from previous and present potential sources of contamination and were included in the previous RI as background control sites; and
- 4) Crab Orchard Lake (Site 34; Figure 2) is currently being monitored and/or studied by the Illinois Department of Public Health, Illinois State University and the U.S. Fish and Wildlife Service.

Eleven of the Misc AOU sites (Table 1) are within three designated industrial areas: D Area (Sites 7, 7A, 8 and 20; Figure 3), P Area (Sites 9, 10, 11 and 11A; Figure 3), and Area 14 (Sites 12, 13 and 14; Figure 4)) that was established when the Refuge facility was operated as the Illinois Ordnance Plant. Industrial and investigative histories of these sites are presented below, following the description of their respective area. The remaining sites (Sites 16, 18, 21, 22A, 24, 25, 26, 27, 30, 31, 34, 35, and 36) are then discussed in numerical order.

1.7.1 D Area

D Area was originally used by Universal Match under a contract with the DOD until a large fire ended their operations (O'Brien and Gere, 1988). The area is currently operated

by Olin Chemical Corporation for the manufacture of explosives, munitions and air bag detonators. Four individual Misc AOU sites are included in D Area: Sites 7, 7A, 8 and 20 (Figure 3). The four sites were investigated as part of the previous RI (O'Brien and Gere, 1988). Those activities are discussed in Section 5.2.

1.7.1.1 Site 7 - D Area Southeast Drainage Channel

The area of concern at Site 7 consists of a drainage channel adjacent to the D Area facilities (Figure 5). The drainage channel contributes discharge to Crab Orchard Lake. Mercury was detected at Site 7 in a composite sediment sample and its duplicate (.040 $\mu\text{g/kg}$ and .30 $\mu\text{g/kg}$, respectively) during the previous RI (O'Brien and Gere, 1988).

1.7.1.2 Site 7A - D Area North Lawn

Site 7A is a 3-acre grassy plot located in the northwest corner of D Area (Figure 5). O'Brien and Gere (1988) state that barrels of chemicals were reportedly dumped on a knoll within the area. During the previous RI, magnetometer and electromagnetic surveys did not detect anomalies suggestive of buried metallic objects; mercury was detected in six composite soil samples at concentrations ranging from 0.022 mg/kg to 0.029 mg/kg. No evidence of a knoll was found during the site visit conducted on October 28, 1992. The area of concern for the RI is the lawn.

1.7.1.3 Site 8 - D Area Southwest Drainage Channel

Site 8 is a drainage way that receives run-off from the active industrial facility within D Area and discharges into Crab Orchard Lake (see Figures 3 and 5). Previous sample collection at the site did not detect any potential contaminants (O'Brien and Gere, 1988). The area of concern is the drainage way.

1.7.1.4 Site 20 - D Area South Drainage Channel

A drainage way at Site 20 is the area of concern as it receives runoff from a nearby abandoned building (Figure 6) that was reportedly used to dump chemicals (O'Brien and Gere, 1988).

A composite sediment sample collected from the drainage way during the previous RI detected two semi-volatile organic compounds (SVOCs): bis(2-ethylhexyl)phthalate at an estimated concentration of 2320 µg/kg and N-nitrosodimethylamine (NDMA) at an estimated concentration of 336 µg/kg (O'Brien and Gere, 1988).

1.7.2 P Area

P Area was originally used by Universal Match while operating under contract to the DOD. Those operations ended after a large explosion (O'Brien and Gere, 1988). P Area is now used by Olin Chemical Corporation for research and development, and the manufacture of ammunition.

P Area contains four Misc AOU sites: 9, 10, 11 and 11A (Figure 3). The four sites were investigated as part of the previous RI (O'Brien and Gere, 1988); these activities are discussed below and in Section 5.2.

1.7.2.1 Site 9 - P Area Northwest Drainage Channel

The area of concern at Site 9 is a perennial stream which carries run-off from a watershed area which encompasses munitions manufacturing facilities within D and P Areas. The stream discharges to Crab Orchard Lake (Figure 7). During the previous RI, analysis of a composite sediment sample from the site detected 249 µg/kg of PCBs and 0.009 mg/kg of mercury (O'Brien and Gere, 1988).

1.7.2.2 Site 10 - P Area North Drainage Channel

Site 10 (Figure 7) includes a downstream segment of the same stream as Site 9, and a tributary which receives runoff from an active Olin Chemical facility located to the northwest (Figure 3). The stream and tributary currently merge into a beaver pond that discharges into an embayment of Crab Orchard Lake where the water works has its intake. The areas of concern for Phase-I RI are the stream and tributary.

During the previous RI, the SVOCs bis(2-ethylhexyl)phthalate and NDMA were detected at the estimated concentrations of 540 µg/kg and 270 µg/kg, respectively (both on a wet-

weight basis), in a composite sediment sample taken at the stream discharge area in Crab Orchard Lake (O'Brien and Gere, 1988) .

1.7.2.3 Site 11 - P Area Southeast Drainage Channel

The area of concern at Site 11 is a drainage way which receives runoff from portions of P Area containing a building used for research and development (Figure 7). The drainage way discharges to Crab Orchard Lake (Figure 3).

1.7.2.4 Site 11A - P Area Walkway Structures

Site 11A includes an abandoned L-shaped walkway (Figure 8) which contains areas reportedly used to store production materials for explosives. Chemicals may have been dumped on the ground adjacent to the walkway (O'Brien and Gere, 1988). The areas of concern are small swales and drainage ways where the chemicals may have collected.

1.7.3 Area 14

Area 14 is an active manufacturing area south of Crab Orchard Lake. Three Misc AOU sites are located in Area 14: Sites 12, 13 and 14 (Figure 4). Sherwin Williams loaded and stored munitions in the area until 1947 when Diagraph Corporation took over the buildings. Diagraph presently manufactures printing inks, printing equipment and stencils in the buildings between Site 12 and Site 14.

The three sites were investigated as part of the previous RI (O'Brien and Gere, 1988). The previous activities are described below and in Section 5.2.

1.7.3.1 Site 12 - Area 14 Impoundment

Site 12 consists of a circular impoundment approximately 100 feet in diameter which, in the past, surrounded an above-ground storage tank (Figure 9). The tank was reportedly used to store oil for a boiler previously located nearby. The tank was removed during the early 1960s. Several black oily pools in and around the impoundment, bare patches of black sediment, and tars located in the impoundment were reportedly visible in the

mid-1980s (O'Brien and Gere, 1988). These features were not visibly present at the site when inspected by representatives of the EPA, IEPA, FWS, USACE and Golder Associates (Golder) on October 27, 1992. The area is now overgrown with trees and vegetation. Low areas within the impoundment which collect water are the areas of concern at this site.

1.7.3.2 Site 13 - Area 14 Change House

Site 13 (Figures 4 and 10) is located southeast of Site 14. The site contained a building which was used for several different purposes prior to its demolition sometime between 1971 and 1980. The building was reportedly used as a change house for munitions workers and as a manufacturing facility for explosives and chemicals (O'Brien and Gere, 1988). Site 13 is now an open, grassy field.

Site investigations completed for the previous RI (O'Brien and Gere, 1988) included electromagnetic and magnetometer surveys, and the collection and analysis of six composite soil samples. The investigation area was approximately 1-1/4 acre. O'Brien and Gere (1988) reported that the geophysical surveys did not indicate that major buried objects are present. Delta-BHC (a pesticide) was detected at a concentration of 69 µg/kg in one of the six composite samples. O'Brien and Gere (1988) also assessed the sites' risk to the environment. They concluded that Site 13 does not represent a chemical exposure risk to human health or wildlife receptors at the Refuge or at other locations. No further evaluation was recommended.

According to the Misc AOU Phase I RI Scope of Services (USACE, 1992), the site was also investigated by Environmental Science and Engineering as part of the Uncharacterized Sites investigation. That investigation detected no chemical contamination.

No investigations were planned or conducted at this site as part of the Misc AOU RI. DOI believes that, based on the site's past use, Site 13 belongs in the Explosives/Munitions Area Operable Unit (EMMAOU). The DOI will formally request under the conditions of the FFA that USACE/DOD incorporate the site into the EMMAOU.

1.7.3.3 Site 14 - Area 14 Solvent Storage Drainage Ditch

Site 14 is adjacent to manufacturing and warehouse facilities, including areas where solvents, inks, lubricants and liquid manufacturing supplies are stored in drums and above-ground storage tanks (Figure 10). The tanks presently contain xylene, diethylene glycol and diacetone alcohol. No containment structures were present around the drum storage or tank areas at the time of the site visit on October 27, 1993. The areas of concern are drainage ways and nearby areas which runoff from the drum storage and tank areas.

Previous RI activities include the collection and analysis of three composite sediment samples from the drainage ditches (O'Brien and Gere, 1988). Compounds detected in two of the samples, and their reported concentrations, include NDMA (95 µg/kg), 4-methylphenol (273 µg/kg) and bis-(2-ethylhexyl)phthalate (270 µg/kg).

1.7.4 Site 16- Area 7 Industrial Park

Site 16 is located within Area 7, an industrial park which originally contained 36 large buildings arranged in six rows (Figure 4); each row was served by a railroad spur. A drainage way bisects the park and receives runoff from the entire industrial park. It discharges to Crab Orchard Lake, approximately 2,000 feet to the north. In the mid-1980s, black residues were observed near three buildings formerly used to recover and recycle waste oil, and around two buildings occupied by a company which refurbished mining equipment (O'Brien and Gere, 1988). A former plating facility upstream of Site 16 is the subject of a Metals Area OU investigation.

During the previous RI, three composite sediment samples and nine composite soil samples were collected in the area of the five buildings, and analyzed for a variety of compounds (O'Brien and Gere, 1988). SVOCs were detected in two samples: a composite soil sample collected on the south side of buildings 5-2 and 5-3 (see Figure 11) and a composite sediment sample from the north-south ditch. The detected SVOCs and their respective concentrations, on a wet-weight basis, were bis(2-ethylhexyl)phthalate (44 µg/kg and undetected); anthracene (256 µg/kg and undetected); chrysene (253 µg/kg and estimated at 41 µg/kg); dibenzofuran (estimated at 6 and 50 µg/kg); di-n-butylphthalate

(7 and 41 $\mu\text{g/kg}$); fluoranthene (389 $\mu\text{g/kg}$ and undetected); naphthalene (undetected and estimated at 51 $\mu\text{g/kg}$); NDMA (estimated at 115 $\mu\text{g/kg}$ and undetected); phenanthrene (estimated at 19 and 107 $\mu\text{g/kg}$); and pyrene (356 $\mu\text{g/kg}$ and estimated at 34 $\mu\text{g/kg}$).

The PCB compound Aroclor 1254 was detected in samples collected north of former building 3-5 and south of former buildings 5-2 and 5-3; the concentrations were 2552 $\mu\text{g/kg}$ and 280 $\mu\text{g/kg}$, respectively .

Four of the Site 16 buildings have been razed (Figure 11). The railroad spurs have been removed and the grades have been modified. At the time of the site visit on October 27, 1992, no black residues were observed near the single remaining building, nor the areas where the four buildings had been removed. The drainage way and the area around the one remaining building (Figure 11) represent the areas of concern for Phase I of this RI.

1.7.5 Site 18 - Area 13 Loading Platform

Site 18 is adjacent to an area of approximately 85 bunkers originally built to store 500 pound bombs (Figure 2). All bombs were reportedly removed from the area in 1945. Site 18 consists of a concrete loading platform where the bombs were loaded onto railroad cars. The railroad spurs were removed at some indeterminate date. The site was the subject of two previous investigations.

The DOI has formally requested, under the conditions of the FFA, that USACE/DOD incorporate the site into the EMMAOU; therefore, no further investigations are planned for this site under the Misc AOU RI.

1.7.6 Site 21 - Area 7 Southeast Corner Field

This site is a fenced pasture approximately 150 by 400 feet in size, located near the southeast corner of the Refuge (Figure 4). Large trees growing throughout the site area indicate that the ground has not been disturbed for several decades. Because of concrete rubble visible on the site, it was believed that the area was the location of a dump (O'Brien and Gere, 1988).

Magnetometer and electromagnetic surveys were completed, and six composite soil samples were collected from several site transects and analyzed, as part of the previous RI (O'Brien and Gere, 1988). The geophysical surveys reportedly indicated that no metallic objects were buried at the site. Constituents that were detected in the soil samples (O'Brien and Gere, 1988) and their estimated concentrations are as follows (on a wet-weight basis): 2-methylnaphthalene at 51 µg/kg; dibenzofuran at 18 µg/kg; NDMA at 11 µg/kg; phenanthrene at 105 µg/kg; Aroclor 1254 at 133 µg/kg; and mercury at 0.037 and 0.041 mg/kg. O'Brien and Gere (1988) also performed an evaluation of environmental effects based on the field and analytical results. They concluded that Site 21 does not represent a chemical exposure risk to human or wildlife receptors at the Refuge or other locations and recommended that no further evaluation be performed.

The site was examined by representatives of the EPA, IEPA, FWS, USACE and Golder on October 27, 1992, at which time no signs of contamination were observed and no specific targets for analytical sampling, such as stained soils, seeps or strained vegetation, were observed. A pile of concrete rubble present near the northwest corner of the site appears to be the remains of a building foundation. The Project Work Plans (USACE, 1992a and b) recommended that no additional investigation activities be completed at this site.

1.7.7 Site 22A - Old Refuge Shop Area - Post Treating Facility

Site 22A is part of the former shop and maintenance yard for the Refuge (Figure 30). Site 22A consists of an area where sign posts were treated with diesel fuel containing pentachlorophenol (O'Brien and Gere, 1988). It is believed that the posts were dipped into a tank of the wood preservative then placed in the open to dry. The tank is believed to have been located in a small building/shed. The posts were set out to dry in a gravel area which extended from the building to the west (Figures 12 and 13). The area of concern at Site 22A is the area surrounding the small building/shed and the gravel pad.

Aerial photos indicate that the building and gravel area were present in 1960, 1963, 1965 and 1971, but not in 1951 (USDA, 1951, 1960, 1965, and 1971; USGS, 1963). In the 1960 (Figure 12) and 1963 photos, dark equidimensional items are visible at the perimeter of the gravel pad and are interpreted to be posts stacked on pallets. In addition, the 1960 photo indicates that additional activities, possibly related to the post treating operations,

occured in an area approximately 20 feet due east of the former building. In the 1965 and 1971 photos, other unidentifiable items of random size and shape are stored throughout the area; the post treating facility is believed to have been inactive at this time.

Five soil samples were collected in the post treating facility area in 1989 and analyzed for aromatic hydrocarbons (Texas A&M University, 1989) and cadmium in 1990 (Hazelton Laboratories America, 1990). The samples were collected in a line along the approximate location of the gravel pad and extending approximately 120 feet west from the fence (Figure 13). SVOCs were detected in concentrations between 1 ppm and 3 ppm (on a wet-weight basis) including naphthalene (1 sample), 2-methylnaphthalene (2 samples), 1-methylnaphthalene (5 samples), 2,6 dimethylnaphthalene (2 samples) and 2,3,4-trimethylnaphthalene (1 sample). Cadmium concentration for the five samples were reported to be between 0.19 mg/kg and 1.22 mg/kg, with an average of 0.52 mg/kg (on a dry-weight basis).

Site 22 (Figure 13) nearby was investigated as part of the previous RI (O'Brien and Gere, 1988) and is about to be remediated following investigations conducted for the Metals Areas OU. The remedial action plans are currently being reviewed by the USACE, EPA and IEPA.

1.7.8 Site 24 - West Drainage Ditch

Site 24 consists of a drainage ditch adjacent to a soft drink bottling plant located outside of the Refuge property boundary (Figure 2) and, therefore, is not owned by the DOI. Runoff from the ditch drains through tributaries to Crab Orchard Lake.

The site was investigated by O'Brien and Gere (1988). Although slightly elevated levels of mercury were detected in ditch sediments it was concluded that Site 24 was not a potential source of contamination and did not contribute mercury to Crab Orchard Lake (O'Brien and Gere, 1988). The FFA states that no further work is necessary at this site and, therefore, no RI activities are planned.

1.7.9 Site 25 - Marion Landfill

The old municipal landfill for the City of Marion is located adjacent to Crab Orchard Creek (Figure 2). Site 25 consists of portions of Crab Orchard Creek upstream and downstream of the inactive landfill, and a pond adjacent to the landfill. The site is not located on the Refuge and is not owned by DOI.

Investigations completed by O'Brien and Gere (1988) included the collection and analysis of several composite sediment samples and surface water samples from Crab Orchard Creek and the pond. Of these, one upstream creek sediment sample contained approximately 10.7 mg/kg of cyanide and one downstream creek sediment sample contained approximately 90 mg/kg of cyanide. They concluded that the site was not contributing cyanide to Crab Orchard Lake. The FFA states that no further work is required at Site 25 and, therefore, no RI activities are planned.

1.7.10 Site 26 - Marion Sewage Treatment Plant

The City of Marion sewage treatment plant discharges to Crab Orchard Creek. Site 26 consists of portions of the creek downstream of the plant (Figure 2). It is located outside the Refuge property boundary and is not owned by DOI. O'Brien and Gere's (1988) investigations included the collection and analysis of two composite soil samples, in which no volatile organic compounds (VOCs) or metals were detected. The samples were not analyzed for SVOCs. They concluded that the site did not warrant additional work. The FFA states that no further work is required at this site and, therefore, no RI activities are planned at Site 26.

1.7.11 Site 27 - Crab Orchard Creek Dredge Area

A number of years ago, Crab Orchard Creek was dredged approximately 1-1/4 miles downstream of Interstate Highway 57. Site 27 is comprised of sections of the dredged creek and adjacent floodplain areas north of the creek and west of Chamness Road (Figure 4).

Site 27 investigations completed as part of the previous RI (O'Brien and Gere, 1988) included the collection and analysis of one composite sediment sample and one composite surface water sample from the creek. They concluded that the sediment sample did not contain concentrations of parameters above control (background) samples, but the surface water sample had concentrations of iron and magnesium which exceeded EPA recommended secondary Maximum Contaminant Levels (MCLs). Monitoring of surface water chemistry was recommended (O'Brien and Gere, 1988).

The floodplain areas of Site 27 were examined on October 28, 1992 by representatives of the EPA, IEPA, USACE, FWS and Golder, at which time no specific targets for analytical sampling were identified. In the Project Work Plans (USACE, 1992b), Phase I sampling and analysis was not recommended because the creek sediments and surface water now present at the site area represent areas upstream that are not part of the Refuge or relevant to the historical aspects of the Refuge being investigated as part of the Misc AOU RI. Recently, the City of Marion and the USACE have announced that the Site 27 area will be dredged as part of a flood control project along Crab Orchard Creek. For these reasons, no RI activities are recommended at Site 27.

1.7.12 Site 30 - Area 13 Munitions Control Site

Site 30, the Munitions Control Site, is an area south of Crab Orchard Lake (Figure 2). As part of the previous RI, soil and groundwater samples were collected from the site and analyzed to represent uncontaminated soil and groundwater conditions (O'Brien and Gere, 1988). The site consists of a low lying area located near bunkers used to store munitions; reportedly, munitions storage is the only industrial activity to have occurred at the site (O'Brien and Gere, 1988).

1.7.13 Site 31 - Refuge Control Site

Site 31, the Refuge Control Site, is an area north of Crab Orchard Lake (Figure 2). The site was used during the previous RI (O'Brien and Gere, 1988) as a control site to represent background soil and groundwater conditions. According to the Refuge Manager at that time, Site 31 area was not involved in any past industrial activities.

Furthermore, a water supply well drilled nearby was tested and found to be free of contaminants (O'Brien and Gere, 1988). No RI activities are required at the Site.

1.7.14 Site 34 - Crab Orchard Lake

Site 34 consists of Crab Orchard Lake (Figures 1 and 2). The lake water and sediments, and associated wildlife populations, have been subject to various investigations completed by the FWS, Southern Illinois University, the State of Illinois, and O'Brien and Gere (USACE, 1992; O'Brien and Gere, 1988). Monitoring of the lake and wildlife populations is a continuing process at the Refuge, therefore, no RI activities are recommended.

1.7.15 Site 35 - Area 9 East Waterway

Site 35 consists of a low-lying area in an agricultural field (Figure 4). O'Brien and Gere (1988) reported that the lack of vegetation in the depression potentially indicated the presence of contaminants; therefore, they investigated the site. One composite soil sample was collected and analyzed. A trace of PCBs (16 $\mu\text{g/kg}$ of Aroclor 1254) was detected (O'Brien and Gere, 1988). A qualitative assessment of environmental effects was performed. They concluded that the site does not represent a chemical exposure risk to human or wildlife receptors and recommended that no further evaluation be conducted.

The site area was visited by representatives of the USEPA, IEPA, FWS, USACE and Golder on October 28, 1992. During the site visit, the area of the reported depression contained a crop of about 8-foot high corn; no signs of potential contamination were observed. Because of the previous RI results and the lack of specific sampling targets, no RI activities are recommended at Site 35 (USACE 1993 a,b).

1.7.16 Site 36 - Area 3 North Waste Water Treatment Plant

The waste-water treatment plant (Figure 3) was built in the mid-1940s to process waste water from industrial and FWS facilities within the eastern portions of the Refuge. The original equipment, which is still in use, includes three aeration tanks, an anaerobic digestion tank, sand beds, clarification tanks and a chlorination system. Dove Creek was dug at that time to carry the discharge into a tributary of Pigeon Creek. Two small ponds

east of the sand beds were created in the late 1950s. Two large lagoons were added south of the aeration tanks in 1970 to 1971. These structures are shown on Figure 14 .

According to site personnel interviewed on October 29, 1992, finished water is chlorinated and discharged to the north into Dove Creek. Water removed from sludge in the sand beds probably drains to the adjacent pond (the West Pond). The pond further east (the East Pond) was reportedly used for overflow. In 1960 and 1963 aerial photographs, this pond drained to the south (USDA, 1960; USGS, 1963); in 1965 aerial photographs, the pond is surrounded by trees and the drainage appears dormant (USDA, 1965).

The large lagoons were built as a backup system due to problems with the aeration system in the late 1960s, and are reportedly still used on an occasional basis. Water passes from the primary to the secondary lagoon, is chlorinated, and discharged into Quail Creek. The areas of concern for Phase-I of the RI are Dove Creek, the East Pond, the West Pond and the Lagoons.

2.0 INVESTIGATION METHODS AND PROCEDURES

The methods and procedures for the Phase-I RI activities are described in the approved Project Work Plans (USACE, 1993a, b, c & d). Phase 1 activities include preliminary site visits at Sites 21, 27 and 35, and the collection and analysis of samples from Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, 22A and 36 (Tables 2 and 3). The approved Project Work Plans indicated that no Phase-I investigations be performed at Sites 13, 18, and 34. The FFA states that no further action is required at Sites 24, 25 and 26. This section presents a synopsis of the methods and procedures for the Phase-I investigation and identifies any deviations from the Project Work Plans.

2.1 Preliminary Site Visits

Preliminary site visits were conducted at Sites 21, 27 and 35 by representatives of the USACE, EPA, FWS, IEPA and Golder on October 27 (Site 21) and 28 (Sites 27 and 35), 1992. Site walkovers were performed during each visit to discuss previous site operations, look for evidence of contamination (e.g. stained soils, seeps or strained vegetation) and consider whether additional sampling activities are warranted. Information gathered during the visit, and the results of previous investigations, were used as a basis for recommendations in the Project Work Plans for Phase-I RI activities at the sites. Subsequently, Project Work Plans for Phase-I of the RI were prepared by the USACE (1993a, b, c and d) and approved by the EPA and IEPA.

2.2 Collection of Analytical Samples

Near-surface soil, sediment and sludge samples were collected at 13 sites between April 27 and May 10, 1993, and between June 7 and June 9, 1993. During the first field event, 62 investigative samples were collected and submitted for analyses. Five duplicate samples, four split samples, and four matrix spike/matrix spike duplicate (MS/MSD) samples were also collected and analyzed for Quality Assurance/Quality Control (QA/QC) purposes.

During the second (June) field event, three investigative samples, one duplicate sample, and one MS/MSD sample were collected at Sites 8, 9 and 36 and submitted for analyses

as a substitute for samples collected in May for which laboratory holding times for SVOCs were exceeded. The samples were collected in conformance with the approved SAP procedures.

The sample location selection process and sample collection methods for the three respective media types are described below.

2.2.1 Sample Locations

The locations of Phase I samples are shown in the following site figures:

Figures Showing Sample Locations

<u>Site No.</u>	<u>Figure No.</u>
7, 7A and 8	5
9, 10 and 11	7
11A	8
12	9
14	10
16	11
20	6
22A	13
36	14

Sampling locations within a site were selected on the basis of highest contamination potential. Sampling locations included open drainage ways receiving intermittent run-off from industrialized areas, locations in close proximity to buildings and structures, and locations in areas identified by past investigations as being potentially contaminated.

The SAP identified proposed sampling locations. Samples were collected in conformance with the SAP at each site, with the exception of Sites 10, 11A and 20. The sampling locations for these three sites are shown on Figures 7, 8, and 6, respectively. Sampling locations were adjusted at these three sites because conditions found in the field were different from those originally assumed during preparation of the SAP. Sampling locations were changed at Site 10 because the southern-most grab sample locations were flooded by beaver ponds. Sampling locations were modified at Site 11A because the building was incorrectly located in the SAP. Sampling activities were relocated at Site 20

so that grab samples could be collected closer to the reported source of contamination. These adjustments were made in consultation with the EPA, FWS and IEPA, and were documented in the Daily Quality Control Reports (DQCR) and DQCR Summary Report which is included as an attachment to the Quality Control Summary Report (USACE, 1993F).

Except at Sites 7A, 22A and portions of 36, all sampling locations were staked and surveyed for coordinate location and elevation to the nearest 0.01 feet by a registered surveyor (Cross Country Land Surveyors of Murphysboro, Illinois). At Sites 7A and 22A, only the center location of each composite sample area was surveyed (Figures 5 and 13). At Site 36, the ponds and primary lagoon sample locations were approximated using visual line intersection methods from surveyed stakes on the banks of the water bodies. Surveying was conducted between May 17 and June 7, 1993. Samples collected in June were taken within one foot of the original (May) sample locations and were, therefore, not re-surveyed. Permanent and semi-permanent control points used for the surveying are shown on the respective site figures (Figures 5 through 11 and Figure 13).

2.2.1.1 Soils

Soil samples were collected at nine Misc AOU sites from depths ranging between 0 (ground surface) and approximately 3 feet. Samples were collected from approximately one foot depths at Sites 16 and 22A, and approximately two foot depths at Sites 7A, 8, 11, 11A, 12, 14, 20 and 22A (soil was collected at both depths at Site 22A).

Figures 5 through 11, and Figure 13 show the soil sampling locations for each site. Soil sample descriptions, including sampling depths specific to each site, are included in Table 3.

2.2.1.2 Sediment and Sludge

Sediment samples were collected at Sites 7, 9, 10 and 36. Sludge samples were collected from two ponds and a lagoon at Site 36. Figures 5, 7 and 14 show the sediment and sludge sample locations for Sites 7, 9 and 10, and 36, respectively. Sample descriptions specific to each site are included in Table 3.

Sediment samples were collected from the bottoms of stream channels. The sampled materials were designated as sediments based on field classification. The sediments typically contained coarser textured material than the native soil materials. The streams where these samples were collected are all believed to be perennial; all contained water at the time the samples were collected.

Sludge material was collected at Site 36 from one pond (West Pond) which receives drainage from the sludge drying beds, a second pond (East Pond) which previously received overflow from the treatment plant, and the primary lagoon (Figure 14). The samples were collected at depths of approximately 1 foot below the bottom of the pond/lagoon. The sludge material was characteristically black and rich in organic materials.

2.2.2 Sample Collection Methods

During sample collection activities, the physical and visual nature of the sampled material (including texture, consistency and color) were described in field notebooks. Sample collection methods for all media conformed to the methods provided in the SAP. These methods are described briefly below.

2.2.2.1 Soils

Each soil sample required the collection of one discrete sample (for VOC analysis) and a composite sample consisting of 5 aliquots, each from a separate location, for analysis of all other parameters. The discrete and composite samples are referred to collectively as a sample pair.

At each sampling location, a clean shovel was used to clear away any existing vegetation and topsoil to the desired minimum sampling depth. Once the desired minimum depths were attained, decontaminated stainless steel sampling devices such as scoops, spoons and hand augers, were used to clear the hole and collect the required volume of soil.

Equal amounts of soil from each sample aliquot location were placed in a decontaminated stainless-steel bowl for compositing. Each composite sample was thoroughly mixed once

and, in the process, soil aggregates were reduced to a diameter of less than 1/4 inch. The sample was then divided into quadrants; opposite quadrants were combined and mixed thoroughly in separate bowls; the sample halves were then recombined and mixed thoroughly. The sample was divided into quadrants a second time and processed as before. The sample was divided into quadrants a third time and the homogenized sample material was then placed into analytical-grade jars. Each analytical-grade sample jar was filled with material from different quadrants.

The soil sampling locations for VOC analysis were based on criteria described in the SAP. At Sites 7A, 8, 11 and 20, the VOC samples were collected at predetermined locations indicated in the SAP. At Sites 11A, 12, 14, 16 and 22A, headspace measurements were taken of soil material obtained from the location of each aliquot of the composite sample to determine the location for collecting the discrete VOC sample.

The headspace measurements were taken by loosely placing the soil in a clear, precleaned jar, sealing the jar with a continuous sheet of aluminum foil, and using the jar lid to secure the foil. The sample jars were only partially filled to allow for headspace volatilization, capture and measurement. After a minimum of 30 minutes had elapsed, the intake tube of a photoionization detector (PID) was inserted through the aluminum foil and into the headspace area to measure the concentration of VOC vapors. The peak reading was recorded in the field notebook. The grab sample location with the highest PID reading was selected as the location for collecting the discrete VOC sample. If no vapors were detected, secondary criteria, such as unusual soil discoloration and odors were used to determine the VOC sample location. Headspace measurement information, is included in Table 3.

The SAP specified the use of a PID equipped with an 11.4 eV lamp for headspace screening of grab samples obtained at Sites 11A, 12, 14, 16 and 22A. The first PID instrument for Phase I had a 11.4 eV bulb, but failed to operate by battery supply. A replacement PID was requested and in the interim, an 11.7 eV PID was made available by the EPA oversight. The inoperable PID was replaced by a PID with a 11.8 eV lamp, as an instrument with an 11.4 eV lamp was unavailable. An additional 10.0 eV PID was obtained as backup. It was observed in the field that the 10.0 eV PID was more sensitive to organic vapors by yielding higher readings than the 11.7 and 11.8 eV PIDs. Therefore,

it was decided by the filed team that both the 10.0 eV lamp and a higher intensity lamp (11.7 or 11.8 eV, depending on availability) be used, whenever possible, for headspace screening purposes. The PID substitutions are documented in the Daily Control Reports and the QCSR.

A hand-held stainless-steel core sampler was used to obtain discrete soil samples. A new, cleaned stainless steel liner was used in the sampler device to collect each sample and to keep the sample intact until it was delivered to the laboratory and removed for analysis. Upon retrieval of the soil material from the ground, the sample was removed from the sampler, covered with aluminum foil and plastic end caps, sealed in a plastic bag and placed on ice. All samples for VOC analysis, including investigative samples, QA split samples and QC duplicate samples, were collected from a location within one foot of, and at the same approximate depth as, the aliquot for the composite sample.

In some instances, a sample was removed from the ground that required additional material to fill void space at its ends. When this occurred, a clean stainless steel spoon and/or spatula was used to retrieve more material from the hole and pack it into the end of the sample.

Once sample collection activities were completed, excess sample material was placed in its original hole and covered with the original topsoil and vegetation. A location identification stake was set at that time and surveyed at a later date.

2.2.2.2 Sediment and Sludge

Sediment

Grab sediment samples from the desired depth were obtained from five locations at each site using decontaminated stainless-steel sampling equipment. Equal amounts of grab sediment sample material from each sample location was composited in a stainless-steel bowl. The sediment samples were typically saturated with water; no effort was made to decant the water.

Each composite sample was thoroughly mixed and aggregates were reduced to a diameter of less than 1/4 inch. The sample was then divided into quadrants and opposite quadrants were combined and thoroughly mixed in separate stainless-steel bowls and then recombined. The recombined composite sample was thoroughly mixed. This process was continued a second time after which the sample was divided into quadrants and a set of opposite quadrants were combined and thoroughly mixed in a stainless-steel bowl. This homogenized sample mixture was again divided into quadrants. Separate quadrants were used to fill each analytical grade sample jar. The sample jars were then placed on ice and the unused sample material was returned to the grab sample locations.

Discrete samples for VOC analysis were obtained using a hand-held stainless-steel core sampler with a stainless-steel liner, as described above in Section 2.2.2.1.

Quality control duplicate samples for soils and sediments were collected in an identical manner from locations adjacent to the investigative sample location. Quality Assurance split samples and matrix spike/matrix spike duplicate samples were collected at the completion of the compositing process from different quadrants of the mixing bowl.

Sludge

Sludge samples were obtained from the primary lagoon and ponds east of the WWTP using a Wildco sediment and sludge sampler. A stainless-steel liner was inserted into the Wildco sampler and the sampler was then inserted into the sludge at the designated locations. After retrieving the Wildco sampler, both ends of the stainless-steel liner (with sample inside) were covered with aluminum foil and plastic caps. The sample was kept in the stainless steel liner until the laboratory extracted the sample for VOC analysis.

A plastic liner was used in the sampler to retrieve a sample for the other sludge analyses (i.e., other than VOCs). The sludge was removed from the plastic liner, placed in a stainless-steel bowl, thoroughly mixed with a stainless steel spoon, and placed in analytical grade jars. Split and MS/MSD samples were taken from the same sample material and placed in analytical grade sample jars. The samples were immediately placed on ice.

The sludge samples were typically saturated with water; no effort was made to decant the water.

2.2.3 Sample Shipment

The investigative samples, duplicates, and MS/MSD samples were shipped to the PACE Incorporated laboratory located in Minneapolis, Minnesota for chemical analysis. The split samples were shipped to the USACE Missouri River Division Laboratories. All samples were shipped using an overnight-express carrier. During shipment, the samples were preserved using ice. Upon arrival, sample temperature was verified by the laboratory. The chain-of-custody procedures described in the SAP and QAPP were followed for sample shipment activities.

2.3 Sampling Equipment Decontamination

All sampling equipment such as stainless steel bowls, augers, core samplers, spatulas, and scoops that were used during sampling were decontaminated between each sampling event. On-site decontamination was conducted in a designated area near each site or group of sites. The standard decontamination protocol for sampling equipment was as follows:

- | | |
|--------|---|
| STEP 1 | Equipment scrubbed thoroughly with soft-bristle brush in a low-sudsing Alconox ^(tm) detergent wash solution. |
| STEP 2 | Equipment rinsed with distilled water by spraying. |
| STEP 3 | Equipment rinsed with isopropanol by spraying until dripping; drippings were containerized. |
| STEP 4 | Equipment rinsed with High Performance Liquid Chromatography (HPLC) water by spraying; drippings were containerized. |
| STEP 5 | Equipment was wrapped securely in plastic or aluminum foil for handling and/or storage until next use. |

Decontamination wash and initial rinse waters were disposed of at a sample location at each decontamination area. The containerized isopropanol and HPLC rinse fluids from each site were transferred into 55 gallon Illinois Department of Transportation approved

polyurethane barrels located in a restricted area near the Refuge Visitor's Center that has been designated as a temporary hazardous waste storage area.

2.4 Analytical Parameters

Table 2 lists all analytical parameters for each sample. The general analytical parameters established for Phase-I RI samples include TCL VOCs, TCL SVOCs, TCL pesticides/PCBs; TAL metals and cyanide; and explosives. Samples from one site (Site 22A) were also analyzed for dioxins/furans. The analyses were completed as specified in the Project Work Plans.

2.4.1 Volatile Organic Compounds

The concentrations of TCL VOCs, both halogenated and nonhalogenated, were quantified in soil, sediment and sludge samples using EPA Method 8240. The required quantitation limits for analyzing TCL VOCs in soil, sediment and sludge using Standard Operating Procedures (SOP) method number MN-0-446-B are included in Table 4.

2.4.2 Semivolatile Organic Compounds

The concentrations of TCL SVOCs were measured in soil, sediment and sludge samples using EPA Method 8270. Samples were also analyzed for the compound NDMA, due to site history, using the same analytical method. The required quantitation limits for analysis of TCL SVOCs using SOP MN-O-436-A are included in Table 5.

2.4.3 Organochlorine Pesticides and Polychlorinated Biphenyls

The concentrations of TCL organochlorine pesticides and PCBs (pesticide/PCBs) were analyzed in soil, sediment and sludge samples using EPA Method 8080. The required quantitation limits for the TCL pesticides/PCBs analyses using SOP Method MN-O-447-A are included in Table 6.

2.4.4 Explosives

The concentration of explosives was determined by analyzing soil, sediment and sludge according to EPA Method 8330. The analyte list and method reporting limits are presented in Table 7.

2.4.5 Dioxins/Furans

Soil samples at Site 22A were analyzed for dioxins/furans using EPA Method 8280. The compound list and required reporting limits are presented in Table 8.

2.4.6 Inorganics

The concentrations of TAL metals in soil, sediment and sludge samples was determined using to EPA Methods 3050, 6010, 7060, 7421, 7470, and 7841. TAL cyanide analysis of soil, sediment and sludge was completed using EPA Method 9010. The TAL constituents, required detection limits, and practical quantitation limits are presented in Table 9.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 Climate

The climate in southern Illinois is classified as humid continental with mild winters and relatively warm, humid summers. The Refuge area experiences frequent, short periods of fluctuation in temperature, humidity, cloudiness and wind direction.

At Carbondale, located approximately 10 miles west of the site, data accumulated since 1910 indicates that July, the warmest month, has a mean temperature of 79.8°F and January, the coldest month, averages 34.9° F (O'Brien and Gere, 1988).

Precipitation and temperatures vary greatly throughout the year. The recorded average rainfall is approximately 43 inches, with the heaviest rainfall occurring in May and the lightest in October. Southern Illinois averages 15 days annually of at least 1 inch of snow cover. The soil freezes to a depth of 8 to 12 inches during the winter months.

Windrose information for Carbondale for the period of February 1990 to December 1991 (NAOA, 1992) indicates the predominant annual wind direction to be from South-Southwest at an average velocity of approximately 12 miles per hour with calm winds (< 1.0 mph) for approximately 2% of the year.

3.2 Surface Features

The physiographic region which includes the Refuge is the Mt. Vernon Hill Country of the Till Plains section of the Central Lowlands province (Leighton et al., 1948). The region is characterized by well developed drainage systems with low gradients. The land surface has low relief that represents a bedrock surface modified by glaciation and subdued by a veneer of glacial drift and loess. Upland areas are generally well drained; larger valley bottoms are poorly drained. Relief in the investigative area is generally about 50 feet with elevations ranging between 400 and 450 feet above mean sea level.

3.3 Surface Water Hydrology

Twelve lakes are located within the Refuge. The largest lake is Crab Orchard Lake, constructed in 1940 by the damming of Crab Orchard Creek. The lake has a surface area

of 6,965 acres, a watershed drainage area of 109,261 acres, and a storage capacity of 72,525 acre-feet (O'Brien and Gere, 1988). Water enters the lake through several creeks, including Crab Orchard Creek from the east. Other large lakes are Devil's Kitchen Lake and Little Grassy Lake.

Crab Orchard Lake discharges into Crab Orchard Creek on the western end of the lake. Crab Orchard Creek discharges to Big Muddy River which, in turn, discharges to the Mississippi River.

Surface waters from all of the Misc AOU sites drain to Crab Orchard Lake along pathways shown in Figures 3 and 4. Runoff from Sites 7, 11A and 20 flows south and southwest in an unnamed stream to the lake; Site 9 and the eastern portion of Site 10 are located on the stream. Runoff from Site 7A drains into an unnamed stream which flows approximately 2,500 feet to the lake. Runoff from Site 8 forms an unnamed stream that flows southwesterly approximately 4,000 feet to the lake. Runoff from Site 11 forms an unnamed stream which flows southeasterly, south and southwesterly approximately 3,000 feet to the lake. Runoff from Sites 22A and 36 flow through unnamed streams to Pigeon Creek which flows south approximately 2,000 feet to the lake.

Sites 12, 14 and 16 are located south of Crab Orchard Lake (Figure 4). Runoff from Site 14, and possibly Site 12, flows northward through an unnamed stream approximately one mile to the lake. Runoff from Site 16 flows northward through an unnamed stream approximately 2,000 feet to the lake.

3.4 Geology

The geology of the area includes several types of unconsolidated materials overlying Pennsylvanian sedimentary bedrock (Berg and Kempton, 1988). The unconsolidated materials include soils, alluvium, Wisconsinan loess and lake sediments, and Illinoisan till.

3.4.1 Soils

Poorly drained soil is reportedly developed to depths of several feet in materials locally exposed at the ground surface (Fehbacher and Odell, 1959). Three soil types predominate within the investigative areas; they are the Hosmer Silt Loam, Stoy Silt Loam and Weir

Silt Loam (Fehrenbacher and Odell, 1959). These soil types are typically developed from loess. Soil materials collected at all of the sites during Phase-I, except Sites 7, 9, 10 and 36, were soft to firm, brown, silty clays and clayey silts with a trace of fine sand, and are representative of soil types developed from loess.

A less common soil type in the Refuge area is the Belknap Silt Loam (Fehrenbacher and Odell, 1959). This soil is found in stream valleys and is developed from alluvial deposits. Belknap type soils are reportedly present at Sites 9, 10 and parts of 36 (Fehrenbacher and Odell, 1959). Soil materials collected at these sites during Phase-I include firm brown silty clay with traces of fine- to medium-grained sand (Site 9); soft dark brown clayey silt with some fine-grained sand and a trace of organic material and soft grey silty clay with a trace of organic material (Site 10); and, soft dark grey silty clay with some organic material (Dove Creek at Site 36). These Phase-I soil materials, as well as those from Site 7 (firm, light brown silty clay with traces of fine sand and organics), may represent Belknap soil.

3.4.2 Geology

The thickness of overburden materials generally range between 20 to 50 feet north of the lake, and between 20 to 66 feet south of the lake. Loess is typically less than 20 feet thick and has an average thickness of approximately 15 to 20 feet (Lamar, 1925). The loess consists of clayey silt to silty clay, with traces of fine sand. Till deposits are generally less than 50 feet thick, with the texture ranging from silty clay to clayey silt with traces of fine to medium sand; discontinuous, interbedded sand layers or sandy till are locally present near the base of the till (Linebach, 1979; O'Brien and Gere, 1988; ESE, 1992; Woodward-Clyde, 1992). Alluvium is located in stream and river valleys and consists of very fine- to coarse-grained materials derived from bedrock, till, loess and soils. The thickness of these materials is locally quite variable.

The uppermost bedrock materials vary from sandstone to shale. Lithologic variation occurs within relatively short distances both laterally and vertically (O'Brien and Gere, 1988; ESE, 1992; Woodward Clyde, 1992). The Pennsylvanian bedrock varies in thickness from 800 to 1,400 feet (Willman et al., 1975). Beneath the Pennsylvanian strata are several thousand feet of sedimentary strata overlying Precambrian crystalline rocks (Willman et al., 1975). Sedimentary bedrock in the area dips gently to the north and northeast (Linebach, 1979). There are no known faults in the investigation area. The New Madrid

fault zone is located, however, approximately 60 miles south of the Refuge and has been the source of large historical earthquakes.

3.4.3. Geochemistry

The chemistry of soil, loess and till materials at the Refuge are represented by 36 samples collected in an area on the Refuge immediately south of Area 14 and north of Area 13 (Figure 2). The samples were collected from borings, trenches and the surface (Appendix B; Figure B-1) and analyzed for TCL VOCs, TCL SVOCs, explosives and TAL metals as part of the RI for the Explosives and Munitions Manufacturing Areas Operable Unit (EMMAOU). A description of the samples and investigative procedures is provided in the Phase I Remedial Investigation Report for the EMMAOU (ESE, 1992).

The USACE reviewed the EMMAOU analytical results and prepared a geochemistry database that excluded samples containing explosive compounds and high levels of organic compounds and samples collected from zones containing rubble, metal debris or other visual signs of disturbance (USACE, 1993g).

The USACE database (USACE, 1993g) is included as Appendix B; it contains TAL metal concentrations for 36 samples (24 soils, 8 loess and 4 till) that are believed to represent natural background levels. Five of the database samples were background samples for the EMMAOU Phase-I RI. The remaining 31 samples were EMMAOU Phase-I RI investigative samples. The similarity in the range of metal concentrations between the background samples and the field samples supports the assumption that the field samples have not been impacted by anthropomorphic sources of metal and, therefore, the metal concentrations represent natural levels (USACE, 1993g).

Twenty four samples representing soil material are included in the database. The range, means, and standard deviations of metals concentrations that the USACE calculated from the soil analyses are as follows:

Background Soil Geochemistry

Parameter	Lower Limit of Range (mg/kg)	Upper Limit of Range (mg/kg)	Arithmetic Mean (mg/kg)	Standard Deviation (mg/kg)
Aluminum	7340	28700	13590	4729
Antimony	0.64	2.41	.97	.52
Arsenic	1.76	15.50	5.74	3.05
Barium	59.20	160	105.86	27.05
Beryllium	0.43	0.86	0.64	0.11
Cadmium	0.10	1.35	0.25	0.29
Calcium	645	2250	1196	427
Chromium	8.89	42.90	20.25	7.24
Cobalt	3.66	18.60	9.66	3.65
Copper	6.00	21.10	12.84	4.03
Iron	8410	30800	19913	5877
Lead	7.73	19.50	14.40	3.44
Magnesium	4120	1130	1990	709
Manganese	116	1340	495	292
Mercury	0.034	0.057	0.046	0.015
Nickel	6.51	34.80	15.29	5.63
Potassium	130	1590	649	356
Selenium	0.001	1.500	0.351	0.299
Silver	0.11	0.80	0.42	0.18
Sodium	10.95	451	112.35	94.30
Thallium	0.055	0.630	0.238	0.129
Vanadium	17.30	96	35.35	15.47
Zinc	22.10	208	50.84	34.56

The ranges and arithmetic means of the metal concentrations in the soil database are consistent with the ranges and arithmetic means of a soil sample database for the eastern U.S. prepared by the U.S. Geological Survey (Shacklette and Boerngen, 1984).

3.5 Hydrogeology

Hydrogeologic investigations were conducted by O'Brien & Gere (1988), Environmental Science and Engineering (ESE, 1992) and Woodward-Clyde at several Refuge locations. Groundwater data are available for areas/sites north of Crab Orchard Lake from only O'Brien and Gere (1988). Groundwater data is available for areas/sites south of Crab Orchard Lake from O'Brien and Gere (1988), ESE (1992) and Woodward-Clyde (1992).

Groundwater investigations north of Crab Orchard Lake, for which information is available (O'Brien and Gere, 1988), are limited to the following three locations (Figure 2): Site 17 (located approximately 1 mile northwest of Site 10), Site 22 (located adjacent to Site 22A) and Site 29 (located approximately 1/2 mile southeast of Site 22A). Groundwater investigations south of the lake are limited to following eight locations: COC Area (located approximately 2 miles southwest of Sites 9, 10 and 11) ; Site LD5D and Bunker 1-3 (located approximately 1/4 mile southwest of Site 18) ; COP Area (located approximately 1-1/4 mile west-southwest of Site 14) ; Sites 32 and 33 (located approximately 1/2 mile northwest, west and southwest of Site 35) ; Site 28 (located approximately 3,000 feet northeast of Site 14 and approximately 3,000 feet southwest of Site 16); and Site LF2A (located approximately 1/3 mile south of Site 16 and 1 mile east of Site 12 and 14).

The following general groundwater conditions for the Refuge area are based on the results of the investigations described above:

- Shallow groundwater was generally found at a depth that ranged between 1 and 20 feet below ground surface within a loess or till silty clay/clayey silt unit containing minor amounts of sand and gravel or sand lenses, or at the unconsolidated/bedrock interface. O'Brien and Gere (1988) measured groundwater elevations during the winter and summer of 1987 (wet and dry seasons, respectively) and determined that the water table dropped 3 to 10 feet during the summer months.
- Shallow groundwater flows toward Crab Orchard Lake and the potentiometric surface closely resembles the surface topography, as is typical of unconfined conditions. Minor undulations in the potentiometric surface were interpreted by O'Brien and Gere to be related to surface water tributaries which locally intercept shallow groundwater.

- At Sites 28 and 32 (O'Brien and Gere, 1988), a sandy till aquifer near the lower portions of the unconsolidated sequence, was encountered. Water level monitoring indicated that it was confined at Site 32 and unconfined at Site 28. Groundwater occurring within the sandy till unit, could not be contoured on a regional basis. O'Brien and Gere (1988) believe that groundwater in the sandy till unit probably flows toward Crab Orchard Lake.

3.6 Water Resources

Shallow aquifers located in the loess and till are discontinuous and generally produce enough water to meet domestic and farm needs only from large diameter wells and cisterns. The Pennsylvanian bedrock provides variable supplies of water generally sufficient for domestic, farm and semi-private use. The more abundant source of groundwater in southern Illinois are the Mississippian, Devonian and Silurian aquifers. These are widely used for domestic and farm supplies with some local industrial and municipal use (Pryor, 1956).

The most abundant source of water in the area are lakes and reservoirs. As of June 21, 1993, the Refuge obtains its potable water from Rend Lake, located several miles to the north; prior to that time, the Refuge obtained its water from Crab Orchard Lake.

The City of Marion, located adjacent to the northeast boundary of the Refuge, obtains its water supply from the Marion Reservoir, located approximately two miles east of Crab Orchard Lake. It has been reported that during previous dry seasons, Crab Orchard Lake was used as an auxiliary supply for the City. The last time that the City withdrew water from Crab Orchard Lake was in 1981; that year it withdrew approximately 6 percent of its total annual water supply from the lake. The City now uses water from Herrin Lake as an auxiliary intake.

3.7 Demography and Land Use

The major population centers located near the Refuge include Marion (population 14,545), Carbondale (population 27,033) and Carterville (population 3,630). The Refuge habitat includes 21,000 acres of forested land, 3,000 acres of pine plantations, 11,000 acres of cultivated land and 8,500 acres of lake surface area of which Crab Orchard Lake is the

largest at 6,965 acres. The FWS operates the Refuge with land use distributed between agriculture, industry, recreation and wildlife conservation. The Refuge is a popular fishing, hunting, camping and recreation area. Over one million visitor-use days per year are reported. Most of this usage occurs on the western and southwestern portions of the Refuge, which are separated from the closed eastern portions containing the manufacturing areas.

On the eastern portion of the Refuge, public access is generally limited to authorized personnel. Individual industries have security checkpoints for access to their facilities. Most of the abandoned industrial buildings, as well as the active manufacturing areas, are located within fenced areas or along roadways which are closed to the public. Additional unoccupied areas are also closed to the public to protect wildlife and the ecology.

3.8 Ecology

A Preliminary Ecological Risk Assessment (PERA) for the sites has been completed and is included with this report as Appendix D (Volume II). A summary of habitat and wildlife on the Refuge are provided below.

The Refuge is composed of five interspersed habitat types. These types include tracts of second-growth and cutover forests, old fields, open water, industrial facilities and agricultural lands. The aerial coverage of each habitat type consists of approximately 9,300 acres of open water, 15,200 acres of forests (including 3,000 acres of pine plantations) 11,500 acres of old fields, 5,000 acres of agricultural lands, and 1,500 acres of industrial facilities (U.S. FWS 1992). A brief summary of each habitat type is provided in the PERA (Appendix D).

Wildlife inhabiting the Refuge include white-tailed deer, cottontail rabbits, geese, ducks and bobwhite quail, as well as many non-game species. Crab Orchard Lake supports a large population of large-mouth bass, channel catfish, bluegill, sunfish, and crappie, which are available to sports fishermen (O'Brien & Gere 1988). In addition, there are two active bald eagle nests on the Refuge, one on the southeast side of Grassy Bay and one on the northeast corner of Little Creek (Ruelle, 1987).

4.0 QUALITY CONTROL SUMMARY REPORT

The Quality Control Summary Report (QCSR) addresses analytical results, quality control, data reliability, and any deviations from the field and analytical programs. The QCSR was prepared for the USACE (1993f) by Montgomery Watson. The following are points from the QCSR which summarize the adherence to QA/QC procedures for Phase-I investigations as outlined in the Quality Assurance Project Plan (USACE, 1993d).

- Data Quality Objectives (DQOs) used for this project were DQO Level 1 for screening purposes, and Modified DQO Level 4 for analysis of confirmational sampling.
- There were no deviations from the QAPP.
- QA split samples were analyzed by the USACE Missouri River Division (MRD) Laboratory.
- Montgomery Watson validated the analytical results according to the guidelines presented in the QAPP, laboratory QA manuals, laboratory SOPs, SW-846 Methodologies, and EPA guidance documents, including National Functional Guidelines for Organic Data Review, June 1991 and Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses, July 1988.
- The specific objectives for the precision, accuracy, representativeness, completeness and comparability (PARCC) criteria for the project were generally achieved. The majority of any nonconformances were not considered to have had impact on data quality. The nonconformances are discussed in Section 5.1 of the QCSR (USACE, 1993f). Where nonconformances were considered to impact data quality, qualifiers accompany the concentrations indicated in Tables 10 through Table 15. Section 5.1 of the QCSR (USACE, 1993f) documents all nonconformances.

Several qualifiers are used in Tables 10 through 15. When the measured concentration of the sample was below the method detection limit (MDL) it is often reported as not detected (ND). When the concentration is estimated, the value is qualified with a "J". If a particular compound was detected at a concentration of less than ten times the concentration in the method blank, the sample concentration is reported with qualifiers indicating that is not detected (U) and estimated (J).

5.0 INVESTIGATION RESULTS

The results of Phase I activities that were required in the Phase-I Work Plans (USACE, 1993a, b, c and d) are described below; the activities included three preliminary site visits (Sites 21, 27 and 35) and the collection and analyses of samples at thirteen sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, 22A and 36).

5.1 Results of Preliminary Site Visits

During Preliminary Site Visit activities at Sites 21, 27 and 35, no specific areas of visual contamination (e.g., stained soils, seeps or strained vegetation) were observed.

The three sites were also inspected as part of the Phase-I Preliminary Ecological Risk Assessment. Walkover surveys were completed on July 23, 1993 (see Section 2.2 of Appendix D) during which no adverse effects on the vegetation or macrofauna were noted by the Golder Associates ecological scientists.

5.2 Results of Sample Analyses

The results of the Phase-I analyses for TCL VOC, TCL SVOC, TCL pesticides/PCBs, explosives, dioxins/furans and TAL metals and cyanide analyses are provided in Tables 10, 11, 12, 13, 14 and 15, respectively. The Phase-I analytical results are discussed in this section in relation to Preliminary Levels of Concern (PLC) and Adjusted Preliminary Levels of Concern (APLC). The PLCs/APLC are useful for indicating whether a measured concentration of a constituent is potentially harmful to wildlife or humans. The PLCs/APLCs are used to screen the sample collection and analytical results to determine if additional sampling and analyses are warranted. The results of the PERA were also used to determine if additional sampling and analyses are warranted. Only those sites from which samples were collected during Phase-I are discussed in this section. The analytical results which are indicated on the tables as "not detected" (i.e., ND) are not included in the discussion of investigation results.

5.2.1 Preliminary Levels of Concern

A PLC for each constituent was chosen from a group of candidate values. Table 16 shows the candidate values for the detected organic compounds. Candidate values for the organic compounds were compiled from the following sources: 1) residential exposure scenarios for non-carcinogenic compounds; 2) residential exposure scenarios for carcinogenic compounds; 3) cleanup objectives for Refuge remediation programs; and 4) cleanup objectives for a state-wide remediation program; each of these data sources are described below.

The candidate values from residential exposure scenarios are calculated considering risks to general populations. Values for non-carcinogenic compounds are based on reference doses (RfDs) and a Hazard Quotient (HQ) of 0.3; values for the carcinogenic compounds are based on slope factors (SF) and Incremental Cancer Risk (ICR) of 1 person per 1,000,000 of population. The HQ and ICR values are conservative estimates in that they allow for additive effects from multiple compounds. The calculation methods are consistent with the Risk Assessment Guidance for Superfund (RAGS), Volume I Part B (USEPA, 1989). Appendix C describes the preliminary risk-based calculations.

Cleanup objectives for remediation of PCB-contaminated soils, sediments and sludge at Refuge sites in the PCB Areas OU and Metals Areas OU were established by the EPA (USEPA, 1990a & b). Cleanup objectives for remediation of soils associated with leaking underground storage tanks (LUST) located in Illinois and containing VOCs and SVOCs were established by the IEPA (IEPA, 1991). These clean-up objectives were established by the respective agencies at levels to protect human health and the environment. The clean-up objective values often apply to the total concentration for a group of several related compounds (e.g., PCBs, carcinogenic polynuclear aromatics (PNAs), non-carcinogenic PNAs, and BETX (benzene, ethylbenzene, toluene, and xylenes). In these cases, the value shown in Table 16 for each individual compound, is less than the total value for the group.

The PLC chosen for each detected organic compound is typically the lowest (most conservative) of the four candidate values, except for PCB compounds where a ROD value for the Refuge is used. No candidate values are available for dibenzofuran,

explosive or dioxin/furan compounds. A dioxin/furan PLC is provided in Table 16 that is based on a value used by EPA Region VII for Missouri remediation sites. A PLC was not established for the explosive TNT or the SVOC dibenzofuran..

PLC values were adjusted to compensate for potential dilution of the constituent concentration that may have occurred as a result of collecting and analyzing composite samples. The adjustment is based on the conservative assumption that the detected constituent may have been concentrated in only one aliquot. This is more appropriate for organic compounds (and cyanide, as described below) because they would presumably be in the samples only as a result of manmade (e.g., industrial) activities. Composite samples were collected at nearly all sites for the analysis of TCL SVOC and pesticides/PCBs, TAL metals and cyanide and explosives, except for a few of the samples at Site 36 (the Waste Water Treatment Plant). Composite samples from Site 22A (Post Treating Facility) were also analyzed for dioxins/furans. Discrete samples were obtained for all samples analyzed for VOCs. Because the composite samples always consisted of five aliquots (subsamples), the maximum potential for analyte dilution is 500%. In order to compensate for the dilution, adjusted PLCs (APLCs) were calculated for the SVOCs, pesticide/PCB and dioxin/furan compounds by dividing the PLC by five. The APLC values are used to assess the SVOC, pesticide/PCB, dioxin/furan and cyanide analyses for the composite samples, whereas PLC values are used to assess the results of discrete samples (such as all of the VOC samples, and discrete SVOC and pesticide/PCB samples from Site 36), and the metals analyses - as described below.

For the metals and cyanide, candidate values and the PLCs are presented in Table 17. The sources of candidate values for the metals and cyanide are residential exposure scenarios and from RODs, as described above, and the background soil analyses described in Section 3.4.3. The upper limit of the range of the background soil analyses is used as the candidate value for the metals in Table 17.

Residential exposure scenario values were used, whenever possible, to derive PLCs for the metals and cyanide. However, the ROD value is used for lead and the upper limit of the range of the background results (Section 3.4.3) is used for arsenic, beryllium, cadmium and thallium. No PLC values are provided for the elements calcium, iron, magnesium, potassium or sodium because they are non-toxic under environmental

exposure scenarios (USEPA, 1989). These five elements are, therefore, are not discussed in Sections 5 or 6.

The PLC for cyanide was adjusted (i.e., decreased 5 fold), as described above for the organic compounds, because its analysis was performed on composite samples. The APLC is shown in Table 17. The PLCs for metals were not adjusted because typically all of the TAL metals are naturally occurring and each aliquot of a composite sample contains naturally occurring concentrations that are generally within the range of the background. Therefore, adjusting the PLC for potential composite sample dilution would not be appropriate for screening the analytical results of TAL metals.

Even though the PLCs are used as a reference or screening tool, the comparisons are not intended to be an assessment of potential environmental, wildlife or human health risks. The purpose of screening the analytical results with the PLCs is to make a preliminary determination of which sites may require additional investigations. The PLCs cannot, and should not, constitute the only basis for evaluating potential site risks. A detailed and comprehensive assessment of potential site risks will be presented once all significant data are available.

5.2.2 Site 7 - D Area Southeast Drainage Channel

One composite soil sample was collected (COSE0701/1.7' to 1.8' {Sample ID/Depth}) for analysis of TCL SVOC, pesticides/PCBs, explosives, and TAL metals and cyanide; and one discrete sediment sample (COSE0702/1.9') was collected for analysis of TCL VOCs. Each investigative sample was split for analysis by the MRD laboratory for the same parameters (COSE0703/1.7' to 1.8' and COSE0704/1.9', for COSE0701 and COSE0702, respectively).

Beryllium was detected in the composite sample at a concentration of 0.92 mg/kg which is above the PLC (0.86 mg/kg). All other reported concentrations of TAL metals were within the range of background values.

No TCL VOCs, TCL SVOCs, TCL pesticides/ PCBs, or explosive compounds were detected. The analytical results of the split samples were in agreement with the

investigative samples. The analyte detected during the previous RI (O'Brien and Gere, 1988) (mercury at 0.3 mg/kg) was not detected.

5.2.3 Site 7A - D Area North Lawn

At Site 7A, four composite/discrete soil sample pairs were collected for TCL VOCs, SVOCs, pesticides/PCBs, explosives and TAL metals and cyanide analysis (Figure 5). No QA/QC samples were collected. No TCL or explosive compounds were detected in the four samples. TAL analyses indicate that metal and total cyanide concentrations are below the PLCs.

5.2.4 Site 8 - D Area Southwest Drainage Channel

At Site 8, one composite/discrete soil sample pair was collected for analysis of TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals and cyanide, and explosives. A second discrete soil sample was collected for additional TCL VOC analysis (Figure 5). Beryllium was detected in the composite sample at a concentration of 0.86 mg/kg (COSO0801/1.6' to 1.7') which is equivalent to the PLC (0.86 mg/kg).

Acetone was detected in both discrete samples (70 µg/kg; COSO0802/1.7' and 200 µg/kg; COSO0803/1.6') below the PLC (8,240,000 µg/kg). No TCL SVOCs, TCL pesticides/PCBs or explosive compounds were detected in the site composite sample. Beryllium and acetone were not detected in site samples collected during the previous RI (O'Brien and Gere, 1988).

5.2.5 Site 9 - P Area Northwest Drainage Channel

At Site 9, one composite/discrete soil sample pair (COSE0901/2.0' to 2.1' and COSE0901/2.0' to 2.1'depth; Figure 15) was collected for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals and cyanide, and explosive analyses.

The composite sample contained beryllium at a concentration of 0.89 mg/kg, which is above the PLC (0.86 mg/kg).

No TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, or explosive compounds were detected. In a composite sample collected during the previous RI, beryllium was not detected, but mercury (0.009 mg/kg) and PCBs (249 µg/kg) were detected below the PLCs used in this report.

5.2.6 Site 10 - P Area North Drainage Channel

At Site 10, two composite/discrete sediment sample pairs were collected (COSE1001/1.5' to 1.8' and COSE1002/1.6'; COSE1003/1.8' to 2.3' and COSE1004/1.7' depth) for TCL VOC, SVOC, pesticide/PCB, TAL metals and cyanide, and explosive analyses (Figure 15).

In the southeastern sample, the SVOCs benzo(a)anthracene and benzo(b)fluoranthene were detected above their respective PLCs. Acetone and methyl ethyl ketone (sample COSE1002/1.6') and four SVOCs (bis(2-ethylhexyl)phthalate, fluoranthene, phenanthrene, and pyrene; (COSE1001/1.5' to 1.8')), were detected at concentrations below their respective PLCs. The following is a summary of the PLCs/APLCs and concentrations of organics compounds detected in Site 10 samples:

Site 10 - Detected VOCs and SVOCs

COMPOUND (SAMPLE ID/DEPTH)	PLC/APLC (µg/kg)	DETECTION LIMIT (µg/kg)	COSE1001/COSE1002 SAMPLE CONCENTRATION (µg/kg)
Acetone (COSE1002/1.6')	8,240,000	21	83
Benzo(a)anthracene (COSE1001/1.5' to 1.8')	<0.8 ¹	250	250
Methyl Ethyl Ketone (COSE1002/1.6')	4,120,000	4	20
Benzo(b)fluoranthene (COSE1001/1.5' to 1.8')	<0.8 ¹	240	340
Bis(2-ethylhexyl)phthalate (COSE1001/1.5' to 1.8')	9143	420	390
Fluoranthene (COSE1001/1.5' to 1.8')	1120	128	690
Phenanthrene (COSE1001/1.5' to 1.8')	<840 ²	140	450 ³
Pyrene (COSE1001/1.5' to 1.8')	840	250	510

¹ PLC for total carcinogenic PNAs is 0.8 mg/kg.

² PLC for total non-carcinogenic PNAs is 840 µg/kg.

³ Total concentration for total noncarcinogenic PNAs is 450 to 776 µg/kg.

No TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, or explosive compounds were detected in the sample from the northwest drainage (samples COSE1003/1.8' to 2.3' and COSE1004/1.7').

TAL metal and cyanide concentrations in samples from both stream segments are below their respective PLCs/APLCs.

In a sample collected further downstream (where the stream discharges into Crab Orchard Lake) during the previous RI, none of the compounds were detected except bis(2-ethylhexyl)phthalate at a concentration of 540 $\mu\text{g/kg}$ and N-nitrosodimethylamine (NDMA) at a concentration of 270 $\mu\text{g/kg}$ (O'Brien and Gere, 1988).

5.2.7 Site 11 - P Area Southeast Drainage Channel

One composite/discrete soil sample pair was collected (COSO1101/1.7' to 1.9' and COSO1102/1.3' depth), for analysis of TCL VOCs, SVOCs, pesticides/PCBs, TAL metals and cyanide, and explosives. Each of the investigative samples had a sample split that was analyzed by MRD for the same parameters (COSO1103 and COSO1104, for COSO1101 and COSO1102, respectively).

Beryllium was detected at a level (1.0 mg/kg) above the PLCs (0.86 mg/kg) (1.0 mg/kg).

Acetone was detected below the PLC at an estimated concentration of 280 $\mu\text{g/kg}$ (COSE1102/1.7' depth; Figure 15). No TCL SVOCs, TCL pesticides/PCBs or explosive compounds were detected in the sample.

The previous RI detected NDMA at a concentration of 63 $\mu\text{g/kg}$, 1,1-dichloroethene at a concentration of 14 $\mu\text{g/kg}$ and mercury at a concentration of 51 $\mu\text{g/kg}$ in a composite sediment sample (O'Brien and Gere, 1988). These contaminants were not detected during Phase-I of this RI.

5.2.8 Site 11A - P Area Walkway Structures

At Site 11A, four composite/discrete soil sample pairs were collected (Figure 16; COSO11A01/1.5' to 1.6' and COSO11A05/1.7'; COSO11A02/1.7' to 1.9' and COSO11A06/1.7'; COSO11A03/1.7' to 1.8' and COSO11A07/1.7'; and, COSO11A04/1.7' to 1.8' and COSO11A08/1.8'); each of the composite samples were analyzed for TCL SVOCs, TCL pesticides/PCBs, explosives and TAL metals and cyanide, and each of the discrete samples were analyzed for TCL VOCs. A duplicate composite/discrete sample pair (COSO11A09/1.5' to 1.6' and COSO11A10/1.8') were collected at the sample locations COSO11A01/COSO11A05 (Figure 16).

The explosive compound 2,4,6-trinitrotoluene (TNT) was detected at a concentration of 380 $\mu\text{g/kg}$ in one of the composite samples (COSO11A03/1.7' to 1.8' depth; Figure 16). The pesticide heptachlor epoxide was detected in one sample (COS11A01/1.5' to 1.6') at a concentration of 4.4 $\mu\text{g/kg}$ but was not confirmed in the duplicate sample taken from the same location. PLCs/APLCs are not established for these two compounds.

Acetone was detected in one sample (COSO11A08/1.8') at a concentration of 52 $\mu\text{g/kg}$ and methyl ethyl ketone was detected in two samples (COSO11A07/1.7' and COSO11A08/1.8' depth) at concentrations of 4 $\mu\text{g/kg}$ and 14 $\mu\text{g/kg}$, respectively. These two compounds were detected at concentrations below their respective PLCs. No TCL SVOCs, TCL PCBs or cyanide were detected at Site 11A; TAL metals concentrations do not exceed PLC levels.

Sample analyses for the previous RI (O'Brien and Gere, 1988) detected NDMA and total PCBs at concentrations of 262 $\mu\text{g/kg}$ and 900 $\mu\text{g/kg}$ (respectively) in composite sediment samples collected from the ditch located north of the east-west walkway; and total PCBs at a concentration of 300 $\mu\text{g/kg}$ in a composite sample collected from the ditch located south of the walkway (Figure 16).

5.2.9 Site 12 - Area 14 Impoundment

Two composite/discrete soil sample pairs (COSO1201/1.8' to 2.2' and COSO1203/1.8'; COSO1202/1.9' to 2.2' and COSO1204/1.8' depth) and a duplicate composite/discrete sample pair (COSO1207/1.8' to 2.2' and COSO1208/1.7') were collected at Site 12 (Figure 9).

Four VOCs and two SVOCs were detected at concentrations below their PLCs and are summarized as follows:

Site 12 - Detected VOC and SVOC Concentrations

Analyte	Sample Pair Concentration (composite/discrete)			
	COSO1201/ COSO1203 ($\mu\text{g/kg}$)	COSO1207/ COSO1208 ($\mu\text{g/kg}$)	COSO1202/ COSO1204 ($\mu\text{g/kg}$)	PLC/APLC ($\mu\text{g/kg}$)
Acetone	1700	1,040	59	8,240,000
Methyl Ethyl ketone	7.0	7.0	< 4.0	4,120,000
Methylene chloride	6.0	9.0	ND	85,333
Toluene	<1.0	1.0	11	<11,705
Phenanthrene	ND	320	ND	<840 ²
Pyrene	ND	420	ND	840

NOTES: ND = Undetected

¹ Total concentration of non-carcinogenic PNAs in the sample is in the range 320 to 598 $\mu\text{g/kg}$.

² APLC for total non-carcinogenic PNAs is 840 $\mu\text{g/kg}$.

No TCL pesticides/PCBs, explosives, or cyanide were detected, and TAL metals were detected at levels below their respective PLCs.

During the previous RI, analyses indicated that two composite sediment samples and one composite soil sample from the Site 12 impoundment area contained total organic carbon (TOC) and total Kjeldahl nitrogen at concentrations which ranged between 12,039 mg/kg and 16,673 mg/kg and between 369 and 2,267 mg/kg, respectively (O'Brien and Gere, 1988).

5.2.10 Site 14 - Area 14 Solvent Storage Drainage Ditch

At Site 14, two composite/discrete soil sample pairs were collected (COSO1401/1.4' to 1.5' and COSO1402/1.5'; COSO1403/1.4' to 1.5' and COSO1404/1.5' depth) and analyzed for TCL VOCs, SVOCs and pesticides/PCBs, TAL metals and cyanide, and explosives (Figure 17).

In the southern discrete sample (COSO1402/1.5'), the sum of the reported concentrations for the BTEX compounds (benzene, toluene, ethylbenzene, o-xylene and m,p-xylene)

(43,900 $\mu\text{g/kg}$) was above the PLC for BTEX (11,750 $\mu\text{g/kg}$). In the southern composite sample (COSO1401/1.4' to 1.5'), beryllium was measured at a concentration 1.04 mg/kg, which is slightly above the PLC (0.86 $\mu\text{g/kg}$).

Four organic compounds were detected at concentrations below their PLCs. In the southern samples (Figure 17), the VOC methylene chloride was detected at a concentration of 210 $\mu\text{g/kg}$ (COSO1402/1.5'), and the SVOC di-n-butyl phthalate was detected at a concentration of 310 $\mu\text{g/kg}$ (COSO1401/1.4' to 1.5'). In the northern discrete sample (COSO1404/1.5'), acetone and methyl ethyl ketone were detected at concentrations of 88 $\mu\text{g/kg}$ and 7 $\mu\text{g/kg}$, respectively.

No TCL pesticides/PCBs, explosive compounds, or cyanide were detected at Site 14.

Sediment samples collected and analyzed during the previous RI detected NDMA at an estimated concentration of 95 $\mu\text{g/kg}$, 4-methylphenol at a concentration of 273 $\mu\text{g/kg}$ and bis-(2-ethylhexyl)phthalate at a concentration of 270 $\mu\text{g/kg}$ (O'Brien and Gere, 1988).

5.2.11 Site 16 - Area 7 Industrial Park

Samples collected at Site 16 (Figure 11) consisted of two composite/discrete soil sample pairs (COSO1601/0.5' to 0.6' and COSO1602/1.9'; COSO1603/0.7' to 0.8' and COSO1604/1.8' depth) that were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals and cyanide, and explosives. Splits (COSO1605/0.7' to 0.8' and COSO1606/2.1') for samples COSO1603/COSO1604 were analyzed for the same compounds.

Acetone was detected in both investigative samples (220 $\mu\text{g/kg}$ and 22 $\mu\text{g/kg}$ in COSO1602 and COSO1604, respectively), at concentrations below the PLC (Figure 18); but not in the spit sample (<5.1 $\mu\text{g/kg}$; COSO1606), indicating possible laboratory contamination. The PCB compounds Aroclor-1254 and Aroclor-1260 were detected in soil sample COSO1603 at concentrations of 103 $\mu\text{g/kg}$ and 61 $\mu\text{g/kg}$, respectively. These concentrations are above the APLC for total PCBs (100 $\mu\text{g/kg}$). The PCB compounds were not detected in the split of sample COSO1603 analyzed by MRD (COSO1605).

No TCL SVOCs, TCL pesticides or explosive compounds were detected in the Site 16 samples. Cadmium was detected at a concentration of 0.9 mg/kg (sample COSO1601) and 4.2 mg/kg (sample COSO1603). The PLC for cadmium is 1.35 mg/kg.

During the previous RI, SVOCs and PCBs were detected (O'Brien and Gere, 1988). The SVOCs were detected in a composite soil sample collected on the south side of buildings 5-2 and 5-3 (sample 16-15) and a composite sediment sample (sample 16-4) from the north-south ditch (Figure 18). The detected SVOCs and their respective concentrations, on a wet-weight basis, were bis(2-ethylhexyl)phthalate (44 $\mu\text{g/kg}$ and undetected); anthracene (estimated at 256 $\mu\text{g/kg}$ and undetected); chrysene (estimated at 453 $\mu\text{g/kg}$ and 41 $\mu\text{g/kg}$); dibenzofuran (estimated at 6 and 50 $\mu\text{g/kg}$); di-n-butyl phthalate (undetected and 41 $\mu\text{g/kg}$); fluoranthene (389 $\mu\text{g/kg}$ and undetected); naphthalene (not detected and estimated at 51 $\mu\text{g/kg}$); NDMA (estimated at 115 $\mu\text{g/kg}$ and undetected); phenanthrene (estimated at 19 and 107 $\mu\text{g/kg}$); and pyrene (estimated at 34 $\mu\text{g/kg}$ and 365 $\mu\text{g/kg}$). These results were not confirmed by results from this RI; however, detection limits were elevated with respect to previous (O'Brien and Gere, 1988) reported concentrations, for all of the compounds except anthracene.

The PCB compound Aroclor 1254 was detected during the previous RI in composite samples collected north of former building 3-5 (sample 16-14) and south of former buildings 5-2 and 5-3 (Sample 16-15); the concentrations were 2552 $\mu\text{g/kg}$ and 280 $\mu\text{g/kg}$, respectively (O'Brien and Gere, 1988, Appendix I). These results are, generally, corroborated by the results of this investigations (Figure 18).

5.2.12 Site 20 - D Area South Drainage Channel

The samples collected at Site 20 included one composite/discrete soil sample pair (COSO2001/1.0' to 2.0' and COSO2001/1.5' depth) and a duplicate sample pair (COSO2002/1.0' to 2.0' and COSO2002/1.5' depth) that were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals and cyanide, and explosives (Figure 6).

No TCL VOCs, SVOCs, pesticides/PCBs, cyanide, or explosive compounds were detected. TAL metals were detected at levels below their respective PLCs.

Compounds detected during the previous RI (bis(2-ethylhexyl)phthalate at a concentration of 2320 $\mu\text{g/kg}$, and NDMA at a concentration of 336 $\mu\text{g/kg}$ (O'Brien and Gere, 1988)) were not detected.

5.2.13 Site 22A - Post Treating Facility

At each of four Site 22A locations, a composite sample was collected at two depths (Table 2 and Figure 13) and analyzed for TCL SVOCs and pesticides/PCBs, TAL metals and cyanide, explosives and dioxins/furans. A discrete sample was collected at each of the four deeper composite sample locations (Figure 13) and analyzed for TCL VOCs.

The SVOCs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene were detected at concentrations of 550 $\mu\text{g/kg}$, 390 $\mu\text{g/kg}$, 720 $\mu\text{g/kg}$, and 630 $\mu\text{g/kg}$, respectively. These compounds are all polynuclear aromatic (PNA) compounds and have a common PLC (4 $\mu\text{g/kg}$; APLC of 0.8 $\mu\text{g/kg}$) for total PNAs. The PLC for total PNAs was exceeded with total PNAs of 2290 $\mu\text{g/kg}$.

Acetone, methyl ethyl ketone, phenanthrene, anthracene, fluoranthene, pentachlorophenol, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene were detected at concentrations less than their PLCs. The VOCs and SVOCs detected at Site 22A (Figure 19), their associated detection limits, and their PLCs/APLCs are listed below:

Site 22A - Detected VOC and SVOC Concentrations

Compound Sample ID/Location ¹ /Depth	PLC/APLC ($\mu\text{g/kg}$)	Detection Limit ($\mu\text{g/kg}$)	Sample Concentration ($\mu\text{g/kg}$)
Acetone COSO22A16/D/2.4' COSO22A14/B/2.5' COSO22A12/A/2.5'	8,240,000	18 19 19	65 31 23
Methyl ethyl ketone COSO22A12/A/2.5'	4,120,000	4	5
Pentachlorophenol COSO22A03/C/0.6' to 0.8'	1,063	1000	2300
Phenanthrene COSO22A10/A/1.0' to 1.1'	<840 ²	210	210 ³
Anthracene COSO22A10/A/1.0' to 1.1'	8400	140	200

Compound Sample ID/Location ¹ /Depth	PLC/APLC ($\mu\text{g/kg}$)	Detection Limit ($\mu\text{g/kg}$)	Sample Concentration ($\mu\text{g/kg}$)
Fluoranthene COSO22A07/B/1.0' to 1.2' COSO22A10/A/1.0' to 1.1'	1120	120 128	260 580
Pyrene COSO22A07/B/1.0' to 1.2' COSO22A10/A/1.0' to 1.1'	840	240 250	240 590
Benzo(a)anthracene COSO22A10/A/1.0' to 1.1'	<0.8 ⁴	250	550 ⁵
Chrysene COSO22A10/B/1.0' to 1.1'	<0.8 ⁴	280	630 ⁵
Benzo(b)fluoranthene COSO22A07/B/1.0' to 1.2' COSO22A10/A/1.0' to 1.1'	<0.8 ⁴	220 240	300 ⁵ 720 ⁵
Benzo(a)pyrene COSO22A10/A/1.0' to 1.1'	<0.8 ⁴	250	390 ⁵

Notes:

- ¹ Locations: A = Far west; B = West central; C = East central; D = Far east
- ² These compounds are non-carcinogenic PNAs; the APLC for total non-carcinogenic PNAs is 840 $\mu\text{g/kg}$.
- ³ Total Concentration of non-carcinogenic PNAs in this sample is in the range of 210 $\mu\text{g/kg}$ to 536 $\mu\text{g/kg}$.
- ⁴ These compounds are carcinogenic PAHs (PNAs). The APLC for total carcinogenic PAHs is 0.8 $\mu\text{g/kg}$.
- ⁵ The total concentration for carcinogenic PAHs in the sample is 2290 $\mu\text{g/kg}$ to 3063 $\mu\text{g/kg}$ in sample COSO22A10, and 300 $\mu\text{g/kg}$ to 1767 $\mu\text{g/kg}$ for sample COSO22A07.

The pesticides 4,4'-DDT, 4,4'-DDD and 4,4'-DDE were detected (COSO22A01, COSO22A02, and COSO22A03) Figure 19 below the APLCs. The APLCs of these compounds and the sample concentrations are as follows:

Site 22A - Detected Pesticide Compounds

Compound Sample ID/Location ¹ /Depth	APLC ($\mu\text{g/kg}$)	Detection Limit ($\mu\text{g/kg}$)	Sample Concentration ($\mu\text{g/kg}$)
4,4'-DDT COSO22A01/D/0.8' to 1.0' COSO22A02/D/2.4' to 2.7' COSO22A03/C/0.6' to 0.8'	376	4.0 4.1 4.1	23 6.9 36
4,4'-DDD COSO22A01/D/0.8' to 1.0' COSO22A03/C/0.6' to 0.8'	534	4.0 4.1	4.0 12.1
4,4'-DDE COSO22A01/D/0.8' to 1.0' COSO22A02/D/2.4' to 2.7' COSO22A03/C/0.6' to 0.8'	376	4.0 4.1 4.1	27 6.0 10.9

Notes:

1. Locations: A = Far west; B = West central; C = East central; D = Far east

Dioxin/furan compounds were detected at each of the Site 22A sampling locations, with the majority of sample concentrations being above the APLC for total dioxins/furans of 0.2 µg/kg (Figure 19; Table 14). The total concentration of dioxin/furan compounds in each Site 22A sample is as follows:

Site 22A - Detected Dioxin/Furan Compounds

Sample ID/Location ¹ /Depth	Total Dioxin/Furan Concentration (µg/kg)
COSO22A01/D/0.8' to 1.0'	9.44
COSO22A02/D/2.4' to 2.7'	7.63
COSO22A03/C/0.6' to 0.8'	778.4, 213.1 ²
COSO22A04/C/1.5' to 2.0'	41.3
COSO22A07/B/1.0' to 1.2'	123.3
COSO22A08 & COSO22A13/B/2.0' to 2.5'	53.3, 47.5 ³
COSO22A10/A/1.0' to 1.1'	113.3, 59.1 ²
COSO22A11/A/2.2' to 2.5'	84.2

Notes:

1. Locations: A = Far west; B = West central; C = East central; D = Far east
2. Second value represents concentration in diluted sample
3. Second value represents concentration in duplicate sample (COSO22A13)

No TCL PCBs, explosives or cyanide were detected at Site 22A. TAL metals were detected at concentrations below the PLC.

Samples collected and analyzed in 1989 detected five SVOC compounds at concentrations between 1 ppm and 3 ppm (approximately 1,000 to 3,000 µg/kg; Figure 19; Texas A&M University, 1989); these specific SVOCs were not detected during the present RI.

5.2.14 Site 36: Waste Water Treatment Plant

5.2.14.1 Site 36 - Dove Creek

One composite/discrete sample pair (COSE3601/0 to 1.0' and COSE3602/1.0') and a duplicate pair (COSE3609/0' to 1.0' and COSE3610/1.0' depth) were collected from the

bottom of Dove Creek (Figure 13) and analyzed for TCL VOCs, SVOCs, and pesticides/PCBs, TAL metals and cyanide, and explosives.

Both samples contained concentrations of the pesticide Aldrin and the PCB compounds Aroclor-1248, Aroclor-1254, and Aroclor-1260 that exceeded the APLCs. The compound concentrations and their APLCs are shown in Figure 20 and are summarized as follows:

Site 36 Dove Creek - Concentrations of Detected TCL Pesticide/ PCB Compounds

Compound	APLC ($\mu\text{g/kg}$)	Investigation Sample (COSE3601/0.0' to 1.0') Concentration ($\mu\text{g/kg}$)	Duplicate Sample (COSE3609/0.0' to 1.0') Concentration ($\mu\text{g/kg}$)
Aldrin	7.6	770 ¹	790
Aroclor-1248	<100 ²	8900 ³	15000 ⁴
Aroclor-1254	<100 ²	8200 ³	6800 ⁴
Aroclor-1260	<100 ²	950 ³	770 ⁴

NOTES:

- ¹ Concentration is estimated
- ² These compounds are PCBs; the APLC for total PCBs is 100 $\mu\text{g/kg}$.
- ³ Total concentration of PCBs in this sample is 18050 to 18,342 $\mu\text{g/kg}$.
- ⁴ Total concentration of PCBs in this sample is 22,570 to 22,822 $\mu\text{g/kg}$.

Cadmium was detected above the PLC (1.35 mg/kg) in both the investigative sample (24 mg/kg; COSE3601), and duplicate sample (6.5 mg/kg; COSE3609; Figure 20).

Acetone was detected below the PLC in both the investigative discrete sample (COSE3602/1.0') and duplicate discrete sample (COSE3610/1.0') at concentrations of 93 $\mu\text{g/kg}$ and 95 $\mu\text{g/kg}$, respectively. Fluoranthene was detected at a concentration (120 $\mu\text{g/kg}$) below the APLC in the duplicate sample. Neither of the samples contained detectable quantities of explosive compounds or cyanide.

O'Brien and Gere (1988) provide information on two previous studies. PCBs were detected in sediment samples collected from Pigeon Creek, and from the embayment in Crab Orchard Lake into which Pigeon Creek discharges. The PCB concentrations were reported to be 200 $\mu\text{g/kg}$ in the creek (Ruelle, 1983) and 11000 $\mu\text{g/kg}$ in the bay area (IDPH, 1987). The latter value is above the PLC for total PCBs (500 $\mu\text{g/kg}$).

Pesticide and PCB analyses of sediments collected downstream of the facility were performed in 1988 by the FWS (Wade, 1988). The 1988 samples were collected at several locations (Figure 20) : 1) at the Pigeon Creek discharge into Crab Orchard Lake (approximately 2 miles downstream of the facility); 2) several hundred feet downstream of the Quail Creek - Pigeon Creek confluence; 3) at the Dove Creek - Pigeon Creek confluence; 4) on Dove Creek approximately 1,200 feet downstream of the discharge pipe; and, 5) on Quail Creek approximately 500 feet downstream of the discharge pipe. All samples reportedly contained concentrations of PCBs at values less than the PLC (500 $\mu\text{g/kg}$ total PCBs), except the last described sample which had 560 $\mu\text{g/kg}$ of Arochlor-1254. No pesticides were detected.

5.2.14.2 Site 36 - West Pond

One discrete sludge sample was collected from the west pond (Figure 20). Acetone was detected at a concentration (109 $\mu\text{g/kg}$; COSL3603/0.0' to 1.0') below the PLC. TCL SVOCs, TCL pesticides/PCBs, TAL metals and cyanide, and explosives were not detected.

5.2.14.3 Site 36 - East Pond

Two sludge samples were collected from the east pond and several SVOCs were detected (Figure 20). SVOCs detected at concentrations greater than the PLCs include the following: anthracene, naphthalene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene, benzo(b)fluoranthene, and benzo(a)pyrene. The SVOC 2-methylnaphthalene was detected below its PLC. Dibenzofuran was detected, but does not have a PLC. The compounds, sample detection limits, concentrations and compound PLCs are as follows:

Site 36 East Pond - Detected SVOC Compounds

Compound	Detection Limit COSL3604/COSL3605 ($\mu\text{g/kg}$)	Concentration COSL3604/COSL3605 ($\mu\text{g/kg}$)	PLC ($\mu\text{g/kg}$)
Naphthalene	253/2220	6100/5800	25
2-Methylnaphthalene	5000/4400	18900/13600	329,600
Acenaphthene	2250/1980	28000/18300	8,400
Dibenzofuran	5000/4400	19700/13200	NE
Fluorene	2250/1980	44000/29100	5600
Phenanthrene	2800/2400	50000 ¹ /32000 ¹	<4200 ²
Anthracene	280/2400	9400/6300	42,000
Fluoranthene	2530/2220	24200/14400	5600
Pyrene	5000/4400	13900/8000	4200
Benzo(a)anthracene	500/4400	3900 ³ /2700 ³	<4 ⁴
Bis(2-ethylhexyl)phthalate	830/730	1220/ND	45,714
Chrysene	560/490	2610 ³ /1490 ³	<4 ⁴
Benzo(b)fluoranthene	470/410	3900 ³ /1850 ³	<4 ⁴
Benzo(a)pyrene	500/440	1440 ³ /900 ³	<4 ⁴

NOTES:

ND = Not Detected

NE = Not Established

¹ Total concentration for non-carcinogenic PNAs in this sample is 50,000 to 51,220 $\mu\text{g/kg}$ (COSL3604) and 32,000 to 32518 $\mu\text{g/kg}$ (COSL3605)

² This compound is a non-carcinogenic PNA; the PLC for non carcinogenic PNAs is 4200 $\mu\text{g/kg}$.

³ Total concentration for carcinogenic PNAs in this sample is 11,850 to 13,393 $\mu\text{g/kg}$ (COSL3604) and 6940 to 8291 $\mu\text{g/kg}$ (COSL3605).

⁴ These compounds are carcinogenic PNAs. The PLC for total PNAs is 4 $\mu\text{g/kg}$.

Aldrin, Arochlor-1248, Arochlor-1254, and Arochlor-1260 were detected at concentrations greater than their PLCs in both East pond samples (Figure 20). The compounds, sample detection limits, sample concentrations and compound PLCs are as follows:

Site 36 East Pond - Detected Pesticide and PCB Compounds

Compound	Detection Limit COSL3604/COSL3605 ($\mu\text{g/kg}$)	Concentration COSL3604/COSL3605 ($\mu\text{g/kg}$)	PLC ($\mu\text{g/kg}$)
Aldrin	4700/4100	3300/1580	38
Aroclor-1248	9200/8000	42000 ¹ /20700 ¹	<500 ²
Aroclor-1254	9200/8000	80000 ¹ /34000 ¹	<500 ²
Aroclor-1260	9200/8000	7800 ¹ /4100 ¹	<500 ²

NOTES

¹ These compounds are PCBs. The concentration of total PCBs in these samples is 57,800 to 58,262 $\mu\text{g/kg}$ (COSL3604) and 58,800 to 59,203 $\mu\text{g/kg}$ (COSL3605).

² The PLC for total PCBs is 500 $\mu\text{g/kg}$.

Cadmium and antimony was detected in both samples above the PLC. Lead and thallium were detected above the PLC in the eastern sample (COSL3605).

The sample concentrations and the respective PLCs for these TAL metals are as follows:

Site 36 East Pond - Metals Exceeding the PLC

Metal	Concentration COSL3604/COSL3605 (mg/kg)	PLC (mg/kg)
Antimony	39/19.5	2.41
Cadmium	16.7/27	1.35
Lead	500/320	450
Thallium	0.72/ND	0.63

NOTED: ND = Not detected

Other TAL metals were below their respective PLC's and within the range of background concentrations (Appendix B).

VOCs were detected in the East Pond samples at concentrations less than the PLCs (Figure 20). The western sample (COSL3604) contained 800 $\mu\text{g/kg}$ methylene chloride. The eastern sample (COSL3605) contained 880 $\mu\text{g/kg}$ of acetone, 161 $\mu\text{g/kg}$ of methyl ethyl ketone, 61 $\mu\text{g/kg}$ of o-xylene and 58 $\mu\text{g/kg}$ of m,p-xylene.

5.2.14.4 Site 36 - Primary Lagoon

Two sludge samples were collected from the primary lagoon at the locations shown on Figure 20.

Cadmium was detected in both the northern and southern sludge samples at concentrations of 13.0 mg/kg (COSL3606/0.0' to 1.0'), and 29 mg/kg (COSL3607/0.0' to 1.0'), which are above the PLC (1.35 mg/kg). Acetone was detected in both the northern and southern sludge samples at low-level concentrations of 4 $\mu\text{g/kg}$ (COSL3606) and 68 $\mu\text{g/kg}$ (COSL3607), which are below the PLC.

PCBs were detected in both sludge samples below the PLC (Figure 20). The northern sample (COSL3606) contained 59 $\mu\text{g/kg}$ of both Aroclor-1248 and Aroclor-1254, and the total PCB concentration was in the range of 118 to 396 $\mu\text{g/kg}$. The southern sample (COSL3607) contained Aroclor-1248 and Aroclor-1254 at concentrations of 150 $\mu\text{g/kg}$ and 180 $\mu\text{g/kg}$, respectively.

No TCL SVOCs, TCL pesticides, explosive compounds or cyanide were detected in the primary lagoon sludge samples.

5.3 Summary

Samples were collected at 13 sites for the Phase-I investigation. The samples were analyzed for a broad range of organic and inorganic parameters. The compounds detected at each of the sites are summarized in Table 18. TCL VOCs were detected at nine sites, TCL SVOCs at five sites, cyanide at seven sites, TCL pesticides/PCBs at four sites, explosives at one site, and dioxins/furans at one site.

Concentrations of the compounds and analytes were compared to an appropriate PLC or APLC (adjusted PLC for potential dilution) to determine which sites may require additional investigations. At Sites 10, 14, 16, 22A and 36, PLCs or APLCs have been exceeded for select TCL organic compounds and dioxins/furans (Site 22A). At Sites 7, 8, 9, 11, 14, 16 and 36 concentrations of select TAL metals exceed PLCs. At Sites 11A, an explosive compound was detected for which no PLC was established. No compounds or analytes were detected at Sites 7A and 20.

6.0 CONTAMINANT FATE AND TRANSPORT

This section addresses: 1) the nature and extent of compounds detected at concentrations above their PLCs/APLCs at the Misc AOU sites; 2) potential release mechanisms for soil, sediment and sludge; 3) physical properties which typically control migration of the compounds of concern in the environment; and, 4) site specific pathways of concern. This section provides a preliminary evaluation of contaminant fate and transport as a basis for developing recommendations for Phase-II investigations.

6.1 Nature and Extent of Contamination

The known distribution of the compounds that were detected at concentrations exceeding PLCs (compounds of concern), and their possible source(s), are discussed below for the ten sites where PLCs/APLCs were exceeded (Sites 7, 8, 9, 10, 11, 11A, 14, 16, 22A and 36). Compounds of concern were not detected at three sites (Sites 7A, 12 and 20). Analytes that are not included in the discussion below are those reported as "non detect" by the laboratory (ND), those not confirmed in duplicate or split samples, and those detected in previous investigations but not confirmed during this RI.

6.1.1 Site 7 - D Area Southeast Drainage Channel

Beryllium is present in a composite sediment sample that was collected from the bottom of a creek at a depth of 1.7 ft. to 1.8 ft. and from an area that extends for approximately 600 feet along the drainage (Figure 5). The detected concentration (0.92 mg/kg) is slightly above the PLC for beryllium (0.86 mg/kg). The creek is adjacent to an active explosives manufacturing facility. The source of the metal is unknown.

Three factors suggest that the beryllium levels reported at this site and several other sites, are a reflection of natural soil variability rather than evidence of site contamination: (1) beryllium concentrations reported at most study sites (except Site 36 -East Pond) were only marginally above levels reported for background soil samples. (2) beryllium concentrations at all sites (except Site 36 - East Pond) were within the range reported for other media collected from background sites (e.g., till), thus there are natural sources of

beryllium in the study area, and (3) there is no obvious anthropogenic source of beryllium in this area.

6.1.2 Site 8 - D Area Southwest Drainage Channel

Beryllium was also detected at this site in a composite soil sample from below a drainage channel at a depth of 1.6 to 1.7 feet and from an area that extends for approximately 300 feet. This creek drains an active explosives manufacturing facilities; the same facility that is drained by the Site 7 Creek. The beryllium concentration detected is 0.86 mg/kg, which is equivalent to the PLC. For an explanation for the source of the metal, see Section 6.1.1 above.

6.1.3 Site 9 - P Area Northwest Drainage Channel

Beryllium was detected at a concentration of 0.89 mg/kg in a composite sediment sample consisting of five subsamples from a depth of 2.0 to 2.1 feet below the creek bottom and from an area that extends for a distance of approximately 700 feet along the creek. This is the same creek as sampled at Site 7. The source of the beryllium is not known; see Section 6.1.1 above for a discussion concerning possible sources.

6.1.4 Site 10 - P Area North Drainage Channel

Benzo(a)anthracene and benzo(b)fluoranthene are present above their PLCs in stream sediments collected from a depth of one to two feet in the eastern portion of Site 10 (Figure 15). These compounds were not detected at Site 9 immediately upstream of Site 10, or at other upstream Misc AOU sites (Sites 7, 20 and 11A; Figure 3). The cause and/or source of the SVOCs is not known.

6.1.5 Site 11 - P Area Southeast Drainage Channel

Beryllium was detected at a concentration of 1.0 mg/kg in a composite soil sample consisting of five subsamples from a depth of 1.7 to 1.9 feet below the drainage ditch and over an area that extends for approximately 200 feet along the ditch. The source of the beryllium in these samples is not known. The ditch drains an area which includes

facilities related to the manufacturing and research and development of explosives. For a discussion of the possible beryllium source, see Section 6.1.1 above.

6.1.6 Site 11A - P Area Walkway Structures

Soils collected from below a drainage ditch at a depth of 1.8 feet contain the explosive 2,4,6-trinitrotoluene (TNT) (Figure 16). The site was investigated because explosive compounds were once stored in the site area. TNT was not detected in the other three Site 11A samples, however, it may be present at low-levels in the sample areas but not be apparent because the analytical detection limit for the samples (300, 310 and 380 $\mu\text{g}/\text{kg}$) were close to the detected concentration (380 $\mu\text{g}/\text{kg}$; COSO11A03/1.7' to 1.8').

6.1.7 Site 14 - Area 14 Solvent Storage Drainage Ditch

The results of this investigation indicate that soils underlying a drainage ditch at a depth of approximately 1.5 feet have been impacted by ethylbenzene, o-xylene, m,p-xylene, and beryllium (Figure 17). Inks and ink-stained soils were observed at the two northernmost grab sample locations during the collection of the sample. The compounds of concern may be from drum and bulk storage areas which contribute runoff to the drainage way. The compounds may then have leached from the sediments into the underlying soils.

6.1.8 Site 16 - Area 7 Industrial Park

Soils collected from a depth of 0.7 to 0.8 feet contain concentrations of PCB compounds Aroclor 1254 and Aroclor 1260 that exceed the APLC for total PCBs. The results of the previous RI indicate that the source of the PCB compounds may be former buildings 3-5, 5-2 and 5-3. These buildings were used for oil recycling and mining equipment rehabilitation; the oil recycling operation may have been a source of PCBs.

6.1.9 Site 22A - Post Treating Facility

Soils at Site 22A are impacted with four SVOCs. The samples were collected in an area which extends over a distance of approximately 160 feet and at a depth of approximately one foot (Figure 19). In addition, several dioxin/furan compounds are present above the

PLC values at depths between 0 and 3 feet, and spanning an area which extends a distance of approximately 320 feet (Figure 19). The compounds may be attributed to the post treating facility formerly located at the site.

6.1.10 Site 36 - Waste Water Treatment Plant

Compounds of concern at Site 36 are present in three areas: Dove Creek, the East Pond, and the Primary Lagoon (Figure 20). Dove Creek contains concentrations of a pesticide, PCBs and cadmium above PLCs. Previous investigations detected concentrations of PCBs (less than the PLC) downstream in Pigeon Creek. The East Pond contains 12 TCL SVOCs, several PCBs, and four TAL metals at concentrations above the PLCs. The Primary Lagoon contains elevated levels of cadmium above the PLC. The lagoon also has PCBs at levels below the PLC. A previous investigation detected PCBs at levels below the PLC in a drainage channel downstream of the pond and the lagoon. The source of contamination at these locations is believed to be effluent and/or overflow (excess capacity) from the waste water treatment plant.

6.2 Release Mechanisms and Potential Pathways

Compounds of concern released from source areas may be transported to additional areas by any one of several pathways. The general release mechanisms for soil, sediment and sludge materials and the transport pathways, are summarized as follows:

- Erosion of soils by surface water runoff,
- wind-blown particulate (dust) transport,
- transport of soil and sediment by foot traffic,
- displacement of sediments/sludge from stream channels or ponds by episodic flood events,
- lateral movement of bedload sediments by surface water,
- volatilization of compounds from soils into the atmosphere,
- chemical leaching of contaminants from soils, sediments and sludges into underlying soils, groundwater or surface water.

Table 19 indicates the relevant potential pathways for each of the source media encountered at the Misc AOU sites. The mechanism(s) by which compounds are released and transported depends on the physical setting of the source and physical/chemical properties of the specific compounds. Volatilization and leaching of compounds are controlled by the compounds' physical characteristics, as discussed in Section 6.3.

The transport of compounds may potentially impact environmental media in other areas. For example, impacted soils eroded by precipitation or surface water will potentially contaminate down slope soils and sediments. Impacted wind-blown dust may impact the ambient atmosphere and downwind soils. Impacted soils and sediments transported by foot traffic will potentially contaminate areas adjacent to trails. Sediments transported by overbank flow may impact soils in low-lying areas adjacent to the stream or pond. Similarly, transport of bedload material will potentially impact down stream sediments. The migration of compounds by leaching may impact groundwater downgradient of the source. The size and location of the area potentially impacted by the compounds of concern will generally be dependant on the strength and direction of the release and transport mechanism. These impacts are summarized in Table 19.

6.3 Physical Properties of Compounds

Compounds in each of the respective analytical groups (i.e., VOCs, SVOCs, dioxins/furans, PCBs, metals, etc.) often have similar physical characteristics. Rather than describing the individual characteristics for each constituent, indicator compounds are selected from the individual analytical groups to represent the general transport behavior for the group.

Desirable characteristics of an indicator compound are high toxicity of similar mobility. Using a compound with these characteristics will lead to a conservative estimate of the potential for contaminant transport. Determining which compounds (of those detected) would make good indicators is facilitated by calculating an indicator score, as described in EPA guidance (USEPA, 1986). The indicator score is the ratio of a representative measured concentration and the toxicity constant for the compound. Of the commonly detected VOC, SVOC, PCB and dioxin compounds, four compounds have toxicity constants available: benzo(a)anthracene, polychlorinated biphenyls (PCBs), 2,3,7,8-TCDD

(a dioxin) and bis(2-ethylhexyl)phthalate. Using the maximum concentrations measured during Phase I (3.9 mg/kg for benzo(a)anthracene, 129.8 mg/kg for total PCBs, and 1.2 mg/kg for bis(2-ethylhexyl)phthalate at Site 36 (COSL3604/0.0' to 1.0') ; 0.778 mg/kg for total dioxin/furans at Site 22A (COSO22A03/0.6' to 0.8') ; the indicator scores are calculated to be 1.1×10^{-4} , 3.6×10^{-3} and 3.4×10^{-9} , and 0.12 respectively (Table 20). As a result of its extremely low score, bis(2-ethylhexyl)phthalate was not used as an indicator compound.

Two additional indicator compounds were included in this discussion to better represent the types of compounds detected during Phase I. Pyrene was included because it is a polynuclear aromatic hydrocarbon (like benzo(a)anthracene); it was detected more frequently, and measured at generally higher concentrations during Phase I, than benzo(a)anthracene. The fifth indicator compound is acetone. Acetone is a volatile organic compound. It has been included because it has physical properties which are very different from the properties of compounds in the SVOC, PCB and dioxin/furan groups. Therefore, VOCs could be expected to exhibit different fate and transport tendencies. Acetone was included rather than the VOCs which were detected at concentrations above PLCs (ethylebenzene, o-xylene, or m,p xylene) because it is more mobile in the natural environment and, therefore, represents a more conservative assessment of fate and transport.

The physical properties of these indicator compounds are described below, and included in Table 21. The data have been taken from Exhibit A-1 of "Superfund Public Health Evaluation Manual" (USEPA, 1986), "Carcinogenically Active Chemicals" (Lewis, 1991) and "Handbook of Environmental Data on Organic Chemicals" (Verschueren, 1983).

6.3.1 Polychlorinated Biphenyls (PCBs)

PCB compounds were once used extensively in electrical equipment (transformers and capacitors), and in the formulation of lubricating and cutting oils, pesticides, plastics, adhesives, inks, paints and sealants. They are probable human carcinogens.

PCBs, as a group, have extremely high octanol/water partition coefficients ($\log K_{ow}$) which indicates they strongly adsorb onto soil particles. They exhibit low water solubility

(indicating that they do not easily leach into water), and very low vapor pressures (indicating that they do not readily volatilize into the atmosphere) (Table 21). These characteristics indicate that PCBs do not migrate significantly from the soil, sediment or sludge materials onto which they are attached. However, if the matrix materials were transported, they would be accompanied by the PCB compounds. Available data indicate that PCBs are very resistant to biodegradation, and they are known to accumulate in the fatty tissues of organisms.

6.3.2 Semi-Volatile Organic Compounds (SVOCs)

Benzo(a)anthracene is a constituent of crude oil and its byproducts, bitumen, wood preservative sludges and coal tar. The compound is also associated with the byproducts of combustion (e.g., ash and cinders). Available information indicates that the compound is not very biodegradable. It is a probable human carcinogen.

Benzo(a)anthracene is a polynuclear aromatic compound that has a very high log K_{ow} , very low water solubility and extremely low vapor pressure. Consequently, benzo(a)anthracene would migrate in a fashion similar to PCBs (i.e., via soil erosion and airborne dust).

Pyrene is also a constituent of crude oil and many of its byproducts, bitumen, coal tar, and byproducts of combustion. Available data indicate that the compound is moderately biodegradable. Pyrene is a possible human carcinogen.

Pyrene is a polynuclear aromatic hydrocarbon compound with a high log K_{ow} , low water solubility, and very low vapor pressure. It is, however, fairly soluble in the presence of organic solvents. Generally, pyrene would tend to migrate in the same potential pathways as benzo(a)anthracene, and PCBs. If high concentrations of organic solvents are also present, pyrene may leach into groundwater.

6.3.3 Dioxins/Furans

Dioxins/furans are a family of compounds which typically has an extremely high log K_{ow} , very low water solubility, and very low vapor pressure. Dioxins/furans would migrate

in the same potential pathways as PCBs and benzo(a)anthracene. Available data indicate they are very resistant to biodegradation (Verschuere, 1983) and may accumulate in organisms. Dioxins vary in their toxicity: 2,3,7,8 TCDD is a probable human carcinogen, HxCDD a probable carcinogen, PeCDD and OCDD are possible carcinogens, and the other dioxin compounds and the furan family of compounds are generally less toxic (Lewis, 1991). No 2, 3, 7, 8 TCDD was detected in samples from Site 22A. Toxicity equivalence factor (TEFs) for these compounds are provided in Appendix III of the PERA report (Appendix D).

6.3.4 Volatile Organic Compounds (VOCs)

Acetone is part of a class of VOCs called keystone. It has a low log K_{ow} , relatively high water solubility, and relatively high vapor pressure. Unlike the SVOC indicator compounds, acetone has a low affinity for soils, is miscible in water, and would tend to volatilize from soil into the atmosphere. Consequently, acetone would migrate via very different potential pathways from those described above. The compound is non-carcinogenic.

6.3.5 Inorganic Compounds

Inorganic compounds (e.g., TAL metals and cyanide) are not represented by indicator compounds because of the complexity of their migration behavior. Typically they migrate under conditions very similar to SVOCs, dioxins and PCB compounds. They have an affinity for soils, sediments and sludges, especially organic-rich materials, and do not readily volatilize or leach into ground and surface water.

Beryllium is one of the more commonly detected metals. Relative to other elements under environmental conditions beryllium, reportedly has low mobility, in oxidizing, acid and neutral to alkaline conditions, and very low mobility to immobile in reducing conditions (Levinson, 1980). According to material safety data sheets for beryllium, it is used for aerospace structures, radio tube parts, inertial guidance systems computer parts, beryllium-copper alloys, gyroscopes; used as an additive to solid propellant rocket fuels, as a neutron source and as a neutron moderator and reflector in nuclear reactors. According to another information source (Bureau of Mines, 1980), beryllium has

numerous and diversified uses; its predominant use in the U.S. is in electronic switchgear, brake shoes and heatshield in aerospace applications; lesser amounts of beryllium are used in the U.S. for plastic molds, dies, tools, springs, tubes, diaphragms, various beryllium compounds, targets for neutron activation analysis equipment and radiation windows. Beryllium is a probable human carcinogenic.

6.4 Pathways of Concern

Each site with elevated concentrations of hazardous constituents may impact human health and the environment via several potential pathways. The pathways which offer the greatest potential threat for the transport of the compounds of concern are identified as the pathways of concern. The pathways of concern, discussed below on a site-specific basis, have been established based on the physical features of the individual sites, and physical properties of the contaminants present.

6.4.1 Site 7 - D Area Southeast Drainage Channel

The compound of concern, beryllium is found in creek sediments. The pathways of concern are tracking of the sediments by foot traffic and movement of the sediments downstream by bedload transport processes. Leaching is not a pathway because the metal is essentially insoluble in water.

6.4.2 Site 8 - D Area Southwest Drainage Channel

Beryllium is found in soils. The pathway of concern is surface runoff that could carry the soils downstream.

6.4.3 Site 9 - P Area Northwest Drainage Channel

Beryllium is found in creek sediments. The pathways of concern are tracking of sediments by foot traffic and movement of the sediments downstream by bedload transport process.

6.4.4 Site 10 - P Area North Drainage Channel

PAHs are found in Site 10 sediments collected from a depth of approximately 1 foot below the bottom of the stream channel. A minor pathway of concern for Site 10 includes the tracking of sediments by foot traffic.

In the past, episodic overbank flow may have deposited impacted sediments onto the nearby floodplain, and bedload transport may have carried sediments further downstream. Beaver dams presently control the stream level, thereby minimizing stream energy levels necessary for bedload transport to occur, and reducing episodic flooding in the site area.

Leaching of compounds is not believed to be a significant pathway, because benzo(a)anthracene, and the related compound benzo(b)fluoranthene, are relatively insoluble.

6.4.5 Site 11 - P Area Southeast Drainage Channel

Beryllium is found in soils at a depth of approximately one foot below the bottom of a drainage way. The pathway of concern is surface runoff that would carry the soils downstream.

6.4.6 Site 11A - P Area Walkway Structures

TNT is present in soils in a drainage ditch. The compound is very sparingly soluble in water (Table 21) and biodegradable in surface water (Verschuere, 1983). The pathways of concern are bedload transport, overbank flow and foot traffic.

6.4.7 Site 14 - Area 14 Solvent Storage Drainage Ditch

The VOCs o-xylene, m,p-xylene and ethylbenzene are present in soils, and possibly in sediments, at concentrations above the PLCs. The pathways of concern include leaching into groundwater, sediment transport, tracking, dust transport and volatilization. Leaching is an important mechanism because VOCs have moderate water solubility and

can therefore migrate into groundwater or surface water. The area of groundwater that could potentially be impacted will be controlled by local groundwater conditions. Sediment transport, tracking and fugitive dust emissions are pathways of concern because xylenes and ethylbenzene have a strong affinity for soil/sediment particles (their low K_{ow} values are approximately 3.2). Volatilization is also a pathway of concern because the vapor pressure of the compounds is moderate (approximately 10 mm Hg).

6.4.8 Site 16 - Area 7 Industrial Park

PCBs, at concentrations above APLCs, are in soils that were collected from below the mouths of tributaries to the north-flowing drainage way. The pathways of concern include soil/sediment transport and tracking.

6.4.9 Site 22A - Post Treating Facility

Dioxins/furans and several SVOCs are present in near-surface soils. The most probable release mechanisms for impacted soils from the site are surface runoff, fugitive dust emissions, and foot traffic. Leaching of the compounds of concern to groundwater is not likely because the compounds do not readily leach into water, and the fine-grained natural soils would inhibit extensive migration. This release mechanism should not be dismissed entirely, because the depth to the water table, and depth to the shallowest aquifer, are not known. Volatilization is not a mechanism of concern because of the very low vapor pressures typically exhibited by the site compounds (i.e., SVOCs and dioxins/furans) that exceeded PLCs.

6.4.10 Site 36 - Waste Water Treatment Plant

At Dove Creek, the most probable release mechanisms for the impacted sediments are bedload transport, foot traffic and overbank flow. The possibility of transport of the compounds of concern via leaching is not considered significant because of the low solubility of the compounds.

At the East Pond and the primary lagoon, the pathways of concern are leaching of compounds into the surface water and/or ground water. Transport of impacted sludge by episodic flooding may occur as a result of high rainfall or overfilling.

7.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This Misc AOU Phase-I RI has been performed in compliance with Section 7.2 of the FFA and in accordance with CERCLA/SARA, the NCP, and approved RI Work Plans. The objectives of the Phase-I RI were to gather analytical and ecological data to characterize sites that have been identified as having potential contaminant sources. A total of 19 sites within the Refuge property were investigated for Phase-I. Eighteen sites were investigated that are included in the Misc AOU, as defined by the FFA. One additional site (Site 22A; a post treating facility) was investigated and is being considered for possible inclusion in the Misc AOU.

Work was performed in accordance with the Project Work Plans approved by the EPA and IEPA. The Phase-I RI Scope of Work included the following activities:

- Conducting preliminary site visits of three Misc AOU sites (21, 27 and 35) to determine whether or not Phase-I environmental sampling is warranted.
- Collecting from 13 sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, 22A and 36), a total of 61 investigative samples consisting of surface soils, sediments and sludges, and analyzing them for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, dioxins/furans, explosive compounds, and TAL metals and cyanide.
- Preparing a preliminary ecological risk assessment (Appendix D) of sites investigated by this RI to determine which of the Misc AOU sites may safely be assumed to pose no threat to ecological receptors and which sites may require additional ecological work.

Based on results from Phase-I investigations, the major conclusions and recommendations for Phase-II RI activities are provided in the following subsections.

7.1 D Area Sites 7 and 8

One composite sample taken at each of Sites 7 and 8 had elevated concentrations of beryllium (relative to the PLC). Other metals did not exceed PLCs and organic compounds were not detected. Site inspections and preliminary screening, based on Phase I analytical results, completed as part of the PERA (Appendix D) indicate that there

is little likelihood of potential ecological risk at these sites. Thus, no further investigations are recommended at Sites 7 and 8.

7.2 D Area Site 7A

At Site 7A, no organic analytes were detected and the reported metal concentrations are below their respective PLCs. Site inspections and preliminary screening, based on Phase I analytical results, completed as part of the PERA (Appendix D) indicate that there is little likelihood of potential ecological risk at these sites. Thus, no further investigations are recommended at Site 7A.

7.3 Sites 13, 18, 21, 27 and 35

Phase I samples were not collected and analyzed at Sites 13, 18, 21, 27 or 35. Site history, site inspections and preliminary screening as part of the PERA (Appendix D) indicate that there is little likelihood of potential ecological risk at these sites. Thus, no further investigations are recommended.

7.4 P Area Sites 9, 11 and 11A, D Area Site 20 and Area 14 Site 12

Samples from Sites 9 and 11 have elevated concentrations of beryllium (relative to the PLC); other metals are at concentrations below their respective PLCs; and, no organic compounds were detected. At Site 12, organic compounds and metals are reported at concentrations below their respective PLCs/APLCs. At Site 11A, metals are reported at concentrations below their respective PLCs, and an explosive compound was detected for which no PLC/APLC is provided. At Site 20, no organic analytes are reported and metal concentrations are below their respective PLCs.

At these sites, the findings of the preliminary ecological risk assessment (Appendix D) indicate that there is little likelihood of ecological risk from the reported organic compounds. However, silver and/or arsenic concentrations are identified in the PERA as potential hazards to ecological receptors. The PERA recommends that additional risk assessment of these sites be completed using the Phase II analytical results from other selected sites (10, 14, 16, 22A, and 36).

7.5 Site 10 P - Area North Drainage Channel

TCL SVOCs are present above PLCs and the PERA (Appendix D) identified that potential hazards to ecological receptors exist. The pathways of concern for Site 10 are tracking of sediments by foot traffic, episodic overbank flow onto the nearby floodplain and bedload transport.

An additional investigation phase is recommended for Site 10 to obtain the following objectives:

1. Obtain additional data concerning TCL SVOCs that were reported in the impacted sample area.
2. Assess whether SVOCs have adversely impacted soils in low lying areas to the northwest and southwest of the impacted area.
3. Evaluate the presence of TCL SVOCs in downstream sediments. This objective will include assessing the presence of SVOCs reported in the previous RI at the stream mouth area.
4. Evaluate whether the compounds of concern are absent in upstream (Site 9) sediments.
5. Assess whether surface water has been impacted.
6. Assess whether ecological species have been impacted and better quantify the risk to ecological receptors.

To meet the above objectives, the following Phase II investigations are recommended:

1. Collection and analysis of discrete sediment samples from locations adjacent to Phase I composite subsample locations in the perennial stream.
2. Collection and analysis of soil samples from low lying areas to the northwest and southwest of the impacted area.
3. Collection and analysis of discrete sediment samples downstream from the known impacted area.
4. Collection and analysis of discrete sediment samples from point bar deposits upstream of the known impacted area. The area upstream of Site 10 (Site 9) was investigated as part of Phase I. Compounds of concern

were not detected in a composite sample; however, the SVOC detection limits were elevated with respect to APLCs.

5. Collection and analysis of biota target species to better quantify the conservative assumptions used in the preliminary ecological risk assessment.

7.6 Site 14 - Area 14 Solvent Storage Drainage Ditch

O-xylene, m,p-xylene and ethylbenzene are present in Site 14 soils, and possibly in sediments, at concentrations above the PLC. The pathways of concern include leaching into groundwater, sediment transport, tracking, fugitive dust emissions, and volatilization. Therefore, additional investigations are recommended for Site 14. Phase II objectives for Site 14 include the following:

1. Assess the vertical and lateral extent of the area impacted with VOCs.
2. Evaluate the presence/absence of compounds of concern in soils/sediments immediately upstream of the impacted area.
3. Locate possible source areas for the compounds of concern identified in the impacted area.
4. Assess whether surface water quality has been impacted by VOCs detected in site soils.
5. Assess whether shallow groundwater quality has been impacted by VOCs detected in site soils.

To meet the above objectives, the following Phase II investigations are recommended.

1. Conduct a soil gas survey.
2. Based on results for the soil gas survey, collect select soil/sediment samples for analysis.
3. Collect discrete soil/sediment sample(s) from the drainage way upstream of the known impacted area to assist with identification of possible sources for the compounds of concern reported during Phase I.
4. Collect discrete soil samples from two potential source locations south of the impacted area. These areas include a grassy lawn approximately 50 feet to the southeast, and an existing drum storage area approximately 70 feet to the southwest.

5. Collect surface water samples.
6. Collect groundwater samples from 3 shallow test monitoring wells (TMWs).

7.7 Site 16 - Area 7 Industrial Park

PCB compounds are present at levels above the APLC for total PCBs in soils taken from below several drainage ways. The pathways of concern are soil/sediment transport and foot traffic.

Recommended Phase II sampling objectives include:

1. confirming the presence of PCB compounds in the Phase I sample area; and
2. determine if the compounds are present in upstream soils/sediments as reported in the previous RI.

Recommended Phase II investigative activities include the collection of discrete soil/sediment samples at Phase I and previous RI sample locations.

7.8 Site 22A - Post Treating Facility

At Site 22A, soils collected from a depth of approximately one foot contain concentrations of four TCL SVOCs above their respective PLC values and soils collected from depths of approximately one to three feet contain concentrations of several dioxin/furan compounds above the PLC values. The most probable release mechanisms for contaminants from the site are fugitive dust emissions, foot traffic, surface runoff, and leaching to shallow groundwater.

The Phase-II objectives at Site 22A include the following:

1. Determine the extent (vertical and lateral) of SVOCs and dioxin/furan compounds in an area;
2. More accurately quantify the concentrations of SVOCs and dioxin/furan compounds within the area where Phase-I composite samples were collected.

3. Assess down-wind areas to evaluate whether impacted dust/soils have been carried off-site by wind.
4. Assess if the SVOCs and dioxin/furan compounds have impacted shallow groundwater quality at the Site.
5. Assess whether ecological species have been impacted by contaminants that have been detected above PLCs.

To address these objectives, the recommended Phase-II activities include the following:

1. Collect several discrete near surface and subsurface soil samples to evaluate the area, and vertical extent of contamination.
2. Collect a downwind soil sample.
3. Collect shallow groundwater samples from test monitoring wells.
4. Collect ecological samples to quantify ecologic exposure pathways.

7.9 Site 36 - Waste Water Treatment Plant

Concentrations of constituents above preliminary levels of concern were detected at Site 36 in the following three areas: Dove Creek, the East Pond, and the Primary Lagoon.

Dove Creek

Dove Creek has concentrations of PCBs and cadmium above the PLCs and the PERA (Appendix D) has determined that a potential threat to ecological receptors may exist. The most probable release mechanisms for the impacted sediments are bedload transport, foot traffic and overbank flow.

Phase II investigations for Dove Creek are recommended, to achieve the following objectives:

1. Assess the vertical and lateral extent of potential contaminants within the Phase I sample area.
2. Assess whether sediment/soil in Dove Creek downstream of the Phase I sample area contains the compounds reported during Phase I.

3. Evaluate whether the water quality of Dove Creek has been adversely impacted by the compounds of concern.

Recommended Phase II investigations for Dove Creek include the following:

1. Collect discrete sediment/soil samples from 2 depths (0 to 1 and 2 to 3 feet) at several locations within the Phase I sample area.
2. Collect discrete sediment/soil sample(s) from Dove Creek between the downstream margin of the Phase I sample area and the confluence of Pigeon Creek.
3. Collect a surface water sample downstream of the known impacted area of creek sediments.

East Pond

Sludges in the East Pond contain 12 TCL SVOCs, several TCL PCBs, cadmium, lead and thallium above PLCs. A nearby drainage way is impacted by PCBs. The pathways of concern include leaching of compounds into the surface water and/or groundwater, and transport of contaminated sludge by episodic flooding.

Phase II objectives for the East Pond include the following:

1. Estimate the approximate volume of sludge for remedial considerations.
2. Assess the vertical extent of the adversely impacted sludge.
3. Evaluate whether East Pond sludges contain dioxin/furan compounds.
4. Evaluate whether the soils underlying the pond are adversely impacted by the constituents detected above PLCs in sludge.
5. Evaluate whether sediments in the former drainage way are adversely impacted.
6. Assess the extent of impacted soils in low-lying areas adjacent to the pond on the west. This area periodically receives overflow from the pond.
7. Assess the pond water quality.
8. Assess whether shallow groundwater quality has been adversely affected.

Recommended Phase II investigations for the East Pond include the following:

1. Measure the depth to the sludge/underlying soil interface at several locations in the pond.
2. Collect discrete samples of sludge at areas of the Pond not sampled during Phase I.
3. Collect discrete samples of soil below the bottom of the sludge layer.
4. Collect a discrete soil/sediment sample from the former drainage way leading south from the pond to Quail Creek.
5. Collect a discrete sample from low-lying areas adjacent to and west of the pond.
6. Collect a surface water sample from the pond.
7. Collect shallow groundwater samples from TMWs.

Primary Lagoon

The primary lagoon contains cadmium above the PLC. The principal pathway of concern is leaching of compounds into the surface water and/or groundwater. Transport of sludge by episodic flooding may also occur as a result of high rainfall or the storage capacity is exceeded by the release of effluent.

Phase II objectives for the Primary Lagoon include the following:

1. Determine the approximate areal extent of the impacted sludge in the lagoon.
2. Evaluate the impact, if any, on surface water quality.
3. Assess whether the downstream sediments/soils in Quail Creek have been adversely affected.
4. Evaluate whether shallow groundwater quality has been adversely impacted.

Recommended Phase II investigations for the Primary Lagoon include the following:

1. Collect discrete sludge samples at various depths.
2. Collect surface water samples.
3. Collect discrete sediment samples from Quail Creek.
4. Collect shallow groundwater samples from test monitoring wells..

Site 36 Ecological Investigations

Recommended ecological studies at Site 36 would focus on assessing the extent of contamination and to more accurately quantify potential risks to ecological receptors. Ecological sample collection and analysis is recommended for target species.

The Scope of Phase-II Remedial Investigations of the Misc AOU will be detailed in a Work Plan for Agency review and approval.

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TABLE 1
PHASE - I RI ACTIVITIES
MISCELLANEOUS AREAS OPERABLE UNIT

<u>Site Number</u>	<u>Area</u>	<u>Site Name</u>	<u>Phase-I Activity</u>
7	D Area	Southeast Drainage Channel	Sampling
7A	D Area	North Lawn	Sampling
8	D Area	Southwest Drainage Channel	Sampling
9	P Area (North)	Northwest Drainage Channel	Sampling
10	P Area (North)	North Drainage Channel	Sampling
11	P Area	Southeast Drainage Channel	Sampling
11A	P Area (North)	Walkway Structures	Sampling
12	Area 14	Impoundment	Sampling
13	Area 14	Change House	No Investigations
14	Area 14	Solvent Storage Drainage Ditch	Sampling
16	Area 7	Industrial Park	Sampling
18	Area 13	Loading Platform	No Investigations
20	D Area	South Drainage Channel	Sampling
21	Area 7	Southeast Corner Field	Preliminary Site Visit
22A	Old Refuge Shop	Post Treating Facility	Sampling
24 ¹	Pepsi Plant	West Drainage Ditch	No Further Action
25 ¹	Crab Orchard Creek	Marion Landfill	No Further Action
26 ¹	Crab Orchard Creek	Marion Sewage Treatment Plant	No Further Action
27	Crab Orchard Creek	Dredge Area	Preliminary Site Visit
30	Area 13	Munition Control Site	No Investigations
31	None Established	Refuge Control Site	No Investigations
34	Crab Orchard Lake	Crab Orchard Lake	No Investigations
35	Area 9	East Waterway	Preliminary Site Visit
36	Area 3 North	Waste-Water Treatment Plant	Sampling

Footnotes:

¹ Not located within Refuge boundaries, nor owned by DOI; FFA specifies No Further Action.

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Site Number and Area	Sampling Date	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Sample Type	ANALYSIS (2)		
					TCL SVOC (8270) TCL Pest/PCBs TAL Metals (6010) Cyanide (9010) Explosives (8330)	TCL VOCs (8240)	DIOXIN/FURANS (8280)
7: D Area	05/07/93	1.7 to 1.8	COSE0701	Investigative-Composite	X		
		1.9	COSE0702	Investigative-Discrete		X	
		1.7 to 1.8	COSE0703	Split-Composite for COSE0701	X		
		1.9	COSE0704	Split-Discrete for COSE0702		X	
7A: D Area	05/07/93	1.4	COSO7A01	Investigative-Composite	X		
		1.9	COSO7A02	Investigative-Discrete		X	
		1.5 to 1.6	COSO7A03	Investigative-Composite	X		
		1.8	COSO7A04	Investigative-Discrete		X	
		1.6 to 1.7	COSO7A05	Investigative-Composite	X		
		1.8	COSO7A06	Investigative-Discrete		X	
		1.5	COSO7A07	Investigative-Composite	X		
		1.9	COSO7A08	Investigative-Discrete		X	
8: D Area	05/06/93	1.6 to 1.7	COSO0801	Investigative-Composite	X		
		1.7	COSO0802	Investigative-Discrete		X	
	05/10/93	1.6	COSO0803	Investigative-Discrete		X	
	06/08/93 (Resampling)	1.6 to 1.7	COSO0801	Investigative-Composite	X		
9: P Area North	05/06/93	2.0 to 2.1	COSE0901	Investigative-Composite	X		
		1.8	COSE0902	Investigative-Discrete		X	
		2.0 to 2.1	COMS0901	MS/MSD-Composite for COSE0901	X		
	06/08/93 (Resampling)	2.0 to 2.1	COSE0901	Investigative-Composite	X		
10: P Area North	05/08/93	1.5 to 1.8	COSE1001	Investigative-Composite	X		
		1.5 to 1.8	COMS1001	MS/MSD-Composite for COSE1001	X		
		1.6	COSE1002	Investigative-Discrete		X	
		1.8 to 2.3	COSE1003	Investigative-Composite	X		
11: P Area	05/07/93	1.7 to 1.9	COSO1101	Investigative-Composite	X		
		1.3	COSO1102	Investigative-Discrete		X	
		1.7 to 1.9	COSO1103	Split-Composite for COSO1101	X		
		1.9	COSO1104	Split-Discrete for COSO1102		X	
11A P Area North	05/10/93	1.5 to 1.6	COSO11A01	Investigative-Composite	X		
		1.5 to 1.6	COSO11A09	Duplicate-Composite for COSO11A01	X		
		1.7	COSO11A05	Investigative-Discrete		X	
		1.8	COSO11A10	Duplicate-Discrete for COSO11A05		X	
		1.7 to 1.9	COSO11A02	Investigative-Composite	X		
		1.7 to 1.9	COMS11A02	MS/MSD-Composite for COSO11A02	X		
		1.7	COSO11A06	Investigative-Discrete		X	
		1.7 to 1.8	COSO11A03	Investigative-Composite	X		
		1.7	COSO11A07	Investigative-Discrete		X	
		1.7 to 1.8	COSO11A04	Investigative-Composite	X		
		1.8	COSO11A08	Investigative-Discrete		X	

NOTES (1) Final depth after sampling.
(2) EPA Method (SW-846)
BGS= Below Ground Surface

SVOCs = Semivolatile Organic Compounds
VOCs = Volatile Organic Compounds
TAL= Target Analyte List (Metals and Cyanide)

Pest/PCB= Pesticides and Polychlorinated Biphenyls
TCL = Target Compound List

TABLE 2 - SAMPLING ACTIVITIES

Site Number and Area	Sampling Date	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Sample Type	ANALYSIS (2)		
					TCL SVOC (8270) TCL Pest/PCBs TAL Metals (6010) Cyanide (9010) Explosives (8330)	TCL VOCs (8240)	DIOXIN /FURANS (8280)
12: Area 14	04/30/93	1.8 to 2.2	COSO1201	Investigative-Composite	X		
		1.8 to 2.2	COSO1207	Duplicate-Composite for COSO1201	X		
		1.8	COSO1203	Investigative-Discrete		X	
		1.7	COSO1208	Duplicate-Discrete for COSO1203		X	
		1.9 to 2.2	COSO1202	Investigative-Composite	X		
		1.8	COSO1204	Investigative-Discrete		X	
14: Area 14	05/05/93	1.4 to 1.5	COSO1401	Investigative-Composite	X		
		1.5	COSO1402	Investigative-Discrete		X	
		1.4 to 1.5	COSO1403	Investigative-Composite	X		
		1.5	COSO1404	Investigative-Discrete		X	
16: Area 7	05/04/93	0.5 to 0.6	COSO1601	Investigative-Composite	X		
		1.9	COSO1602	Investigative-Discrete		X	
		0.7 to 0.8	COSO1603	Investigative-Composite	X		
		0.7 to 0.8	COSO1605	Split-Composite for COSO1603	X		
		1.8	COSO1604	Investigative-Discrete		X	
		2.1	COSO1606	Split-Discrete for COSO1604		X	
20: D Area	04/28/93	1.0 to 2.0	COSO2001	Investigative-Composite	X		
		1.5	COSO2001	Investigative-Discrete		X	
		1.0 to 2.0	COSO2002	Duplicate-Composite for COSO2001	X		
		1.5	COSO2002	Duplicate-Discrete for COSO2001		X	
22A : Old Refuge Shop	04/29/93	0.6 to 0.8	COSO22A03	Investigative-Composite	X		X
		1.5 to 2.0	COSO22A04	Investigative-Composite	X		X
		2.0	COSO22A04	Investigative-Discrete		X	
	04/30/93	0.8 to 1.0	COSO22A01	Investigative-Composite	X		X
		2.4 to 2.7	COSO22A02	Investigative-Composite	X		X
		2.4	COSO22A06	Investigative-Discrete		X	
	05/03/93	1.0 to 1.2	COSO22A07	Investigative-Composite	X		X
		2.0 to 2.5	COSO22A08	Investigative-Composite	X		X
		2.0 to 2.5	COSO22A13	Duplicate-Composite for COSO22A08	X		X
		2.5	COSO22A09	Investigative-Discrete		X	
		2.5	COSO22A14	Duplicate-Discrete for COSO22A09		X	
		1.0 to 1.1	COSO22A10	Investigative-Composite	X		X
		2.2 to 2.5	COSO22A11	Investigative-Composite	X		X
		2.2 to 2.5	COMS22A11	MS/MSD for COSO22A11	X		X
		2.5	COSO22A12	Investigative-Discrete		X	

NOTES (1) Final depth after sampling.
(2) EPA Method (SW-846)
BGS= Below Ground Surface

SVOCs = Semivolatile Organic Compounds
VOCs = Volatile Organic Compounds
TAL= Target Analyte List (Metals and Cyanide)

Pest/PCB= Pesticides and Polychlorinated Biphenyls (PCB)
TCL = Target Compound List

Site Number and Area	Sampling Date	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Sample Type	ANALYSIS (2)		
					TCL SVOC (8270) TCL Pest/PCBs TAL Metals (6010) Cyanide (9010) Explosives (8330)	TCL VOCs (8240)	DIOXIN/FURANS (8280)
36: Area 3 North	05/04/93	0.0 to 1.0	COSL3606	Investigative-Discrete	X	X	
		0.0 to 1.0	COSL3607	Investigative-Discrete	X	X	
	05/05/93	0.0 to 1.0	COSL3603	Investigative-Discrete	X	X	
		0.0 to 1.0	COSL3608	Split-Discrete for COSL3603	X	X	
		0.0 to 1.0	COSL3604	Investigative-Discrete	X	X	
		0.0 to 1.0	COSL3605	Investigative-Discrete	X	X	
	05/06/93	0.0 to 1.0	COSE3601	Investigative-Composite	X		
		0.0 to 1.0	COSE3609	Duplicate-Composite for COSE3601	X		
		1.0	COSE3602	Investigative-Discrete		X	
		1.0	COSE3610	Duplicate-Discrete for COSE3602		X	
	06/09/93 (Resampling)	0.0 to 1.0	COSE3601	Investigative-Composite	X		
		0.0 to 1.0	COSE3609	Duplicate-Composite for COSE3601	X		

NOTES (1) Final depth after sampling.
(2) EPA Method (SW-846)
BGS= Below Ground Surface

SVOCs = Semivolatile Organic Compounds Pest/PCB= Pesticides and Polychlorinated Biphenyls (PCB)
VOCs = Volatile Organic Compounds (Metals and Cyanide)
TAL= Target Analyte List

Site Number	Description	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Media	Sample Description (2)	Comments
7: D Area	SOUTHEAST DRAINAGE CHANNEL: Area currently operated by Olin to manufacture explosives. Sampling conducted in grassy drainage channel leading from active industrial facilities. The 5 grab sample locations were point bars located along the drainage way.	1.7 to 1.8 1.9	COSE0701 COSE0702	Sediment	firm, lt. brown, SILTY CLAY, tr. f-sand, tr. organics	Surface water present in drainage channel. VOC sample COSE0702 taken adjacent to grab 1 (furthest upstream).
7A: D Area	NORTH LAWN: Area currently operated by Olin to manufacture explosives. Sampling conducted in relatively flat open grassy field. The 5 grab sample locations were at the 4 corners and center of an approximately 100 by 100 foot square. A total of 4 such investigative sampling grids were sampled.	1.4 1.9	COSO7A01 COSO7A02	Soil	soft, brown, CLAYEY SILT, tr. f-sand	0 ppm (10.0 and 11.8 eV lamp) on all grabs. VOC sample COSO7A02 taken adjacent to grab 5 at the center of the sampling grid.
		1.5 to 1.6 1.8	COSO7A03 COSO7A04	Soil	soft, lt. brown, CLAYEY SILT, tr. f-sand	0 ppm (10.0 and 11.8 eV lamp) on all grabs. VOC sample COSO7A04 taken adjacent to grab 5 at the center of the sampling grid. Cobbles present at grabs 1, 4 and 5.
		1.6 to 1.7 1.8	COSO7A05 COSO7A06	Soil	soft, brown, CLAYEY SILT, tr. f-sand	0 ppm (10.0 and 11.8 eV lamp) on all grabs. VOC sample COSO7A06 taken adjacent to grab 5 at the center of the sampling grid
		1.5 1.9	COSO7A07 COSO7A08	Soil	soft, brown, CLAYEY SILT, tr. f-sand	0 ppm (10.0 and 11.8 eV lamp) on all grabs. VOC sample COSO7A08 taken adjacent to grab 5 at the center of the sampling grid
8: D Area	SOUTHWEST DRAINAGE CHANNEL: Area currently operated by Olin to manufacture explosives. Sampling conducted in grassy drainage channel running through open field. The 5 grab sample locations were spaced approximately evenly along the drainage way.	1.6 to 1.7 1.7 1.6	COSO0801 COSO0802 COSO0803	Soil	firm, red-brown, SILTY CLAY, tr. f-sand	Surface water present in drainage channel VOC sample COSO0803 taken adjacent to grab 1 (furthest upstream).
9: P Area North	NORTHWEST DRAINAGE CHANNEL: Sampling conducted in a perennial stream which carries run-off from the active P Area to Crab Orchard Lake. Grabs 1, 2, 3 and 5 were located at point bars along the drainage way. Grab 4 was located in a tributary which extends to the north	2.0 to 2.1 1.8	COSE0901 COSE0902	Sediment	firm, brown, SILTY CLAY, tr. f-m sand, tr. m-gravel	Surface water present in drainage channel. VOC sample COSE0902 taken adjacent to grab 5 (furthest downstream).

Notes (1) Final sampling depths of grab samples; composite sample grabs are expressed as a range of final depths when applicable.

(2) Composite sample used for description except where indicated with a (3)

(3) Discrete sample used for description

BGS= Below Ground Surface

All headspace measurements are listed as above background. Typically background was less than 2 ppm.

tr.-trace, f-fine, m-medium, c-coarse, lt.-light

(08726592 WB1/ath)

Site Number	Description	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Media	Sample Description (2)	Comments
10: D Area North	WATERWORKS NORTH DRAINAGE CHANNEL: Sampling conducted in a perennial stream downstream of Sites 7, 9, 11A and 20. This site included two investigative sampling locations: Sample COSE1001 was composited from 5 grabs taken along the northern bank of the stream. Sample COSE1003 was composited from 5 grabs taken from point bars along a tributary emptying into the stream from the northwest.	1.5 to 1.8 1.6	COSE1001 COSE1002	Sediment	soft, dark brown, CLAYEY SILT, some f-sand, tr. organics	Surface water present in drainage channel. VOC sample COSE1002 taken adjacent to grab 5 (furthest downstream).
		1.8 to 2.3 1.7	COSE1003 COSE1004	Sediment	soft, grey, SILTY CLAY, tr. organics	Surface water present in drainage channel. VOC sample COSE1004 taken adjacent to grab1 (furthest upstream).
11: P Area	SOUTHEAST DRAINAGE CHANNEL: Sampling conducted in a drainage channel located to the southeast of Olin active P Area. An Olin building for research and development is located at the head of the drainage channel. The 5 grab sample locations were spaced at approximately 50-foot intervals.	1.7 to 1.9 1.3	COSO1101 COSO1102	Soil	firm, red-brown, SILTY CLAY, tr. f-sand, tr. organics	Surface water present at grab 2. VOC sample COSO1102 taken adjacent to grab 1 (furthest upstream).
11A: P Area North	WALKWAY STRUCTURES. Sampling conducted to the north of P Area in drainage ways adjacent to an abandoned L-shaped walkway. This site included 4 investigative sampling locations: COSO11A01 was composited from 5 grabs taken from shallow grassy ditches surrounding the walkway. COSO11A02 and COSO11A03 were both composited from 5 grabs taken from shallow grassy ditches trending north-south and located to the north of an active shop area. COSO11A04 was composited from 5 grabs spaced evenly along a north-south trending grassy drainage ditch which receives run-off from the site area.	1.5 to 1.6 1.7	COSO11A01 COSO11A05	Soil	firm, brown, CLAYEY SILT, tr. f-sand, tr. m-gravel	0 ppm (10.0 and 11.8 eV lamp) on all grabs. VOC sample COSO11A05 taken adjacent to grab 4 (lowest lying, approximate center of sampling area). Cobbles encountered at grab 3.
		1.7 to 1.9 1.7	COSO11A02 COSO11A06	Soil	firm, grey, SILTY CLAY, tr. organics	2 ppm (10.0 eV lamp) on grab 4, 0 ppm (10.0 and 11.8 eV lamp) on all other grabs. VOC sample COSO11A06 taken adjacent to grab 4 (2 ppm). Surface water present at grab 5.
		1.7 to 1.8 1.7	COSO11A03 COSO11A07	Soil	firm, lt. grey, SILTY CLAY, tr. organics	0 ppm (10.0 and 11.8 eV lamp) on all grabs. VOC sample COSO11A 07 taken adjacent to grab 1 (furthest upstream).
		1.7 to 1.8 1.8	COSO11A04 COSO11A08	Soil	soft, brown, CLAYEY SILT, tr. f-sand, tr. roots and fibers	2.6 ppm (10.0 eV lamp) on grabs 2 and 4. 0 ppm (10.0 and 11.8 eV lamp) on all other grabs. VOC sample COSO11A08 taken adjacent to grab 4 (2.6 ppm,second furthest upstream grab).
12: Area 14	IMPOUNDMENT: Sampling conducted within a circular impoundment located in Area 8. Diagraph ink manufacturing facility to the northwest. This site included 2 investigative samples located in the moderately wooded area: COSO1201 was composited from 5 grabs located in the western portion of the impoundment. COSO1202 was composited from 5 grabs located in the eastern portion of the impoundment.	1.8 to 2.2 1.8	COSO1201 COSO1203	Soil	soft, lt. brown, CLAYEY SILT, tr. red-brown f-sand	0 ppm (11.7 eV lamp) on all grabs. VOC sample COSO1203 taken adjacent to grab 1 (diesel fuel odor). Surface water present at grabs 4 and 5.
		1.9 to 2.2 1.8	COSO1202 COSO1204	Soil	soft, lt. brown, CLAYEY SILT, tr. red-brown f-sand	0 ppm (11.7 eV lamp) on all grabs. VOC sample COSO1204 taken adjacent to grab 2 (sheen on water). Surface water present at grabs 1 and 2.

Notes (1) Final sampling depths of grab samples; composite sample grabs are expressed as a range of final depths when applicable.

(2) Composite sample used for description except where indicated with a (3)

(3) Discrete sample used for description

BGS= Below Ground Surface

All headspace measurements are listed as above background. Typically background was less than 2 ppm.

tr.-trace, f-fine, m-medium, c-coarse, lt.-light

(08726592 WB1/arh)

Site Number	Description	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Media	Sample Description (2)	Comments
14: Area 14	SOLVENT STORAGE DRAINAGE DITCH: Sampling conducted along drainage channels which receive run-off from adjacent manufacturing and warehouse facilities including drums and above-ground storage tanks. This site included 2 investigative sample locations: COSO1401 was composited from 5 evenly spaced grabs taken in the southern most grassy drainage way. COSO1403 was composited from 5 evenly spaced grabs taken in the northern most grassy drainage way. Waters were observed occasionally draining into the northern most drainage way from a buliding adjacent to grab 3 of investigative sample COSO1403.	1.4 to 1.5 1.5	COSO1401 COSO1402	Soil	firm, blue-grey, CLAYEY SILT, tr. f-sand, tr. m-gravel	10 to 2000 ppm (10.0 eV lamp). VOC sample COSO1401 taken adjacent to grab 3 (2000ppm). Red and blue staining observed at grab 1 between 1 and 2 feet. Surface water present in drainage channel.
		1.4 to 1.5 1.5	COSO1403 COSO1404	Soil	firm, grey, CLAYEY SILT, tr. f-sand, tr. f-gravel, tr. roots and fibers	0 ppm (11.8 eV lamp) on all grabs. VOC sample COSO1404 taken adjacent to grab 5 (furthest downstream). Surface water present in drainage channel.
16: Area 7	INDUSTRIAL PARK: Sampling was conducted in an Industrial Park located in Area 7. This site included 2 investigative sampling locations: COSO1601 was composited from 5 grab samples taken from the north side and southeast corner of Building 3-4. Grabs 1 to 3 were taken in a gently north sloping grassy area. Grabs 4 and 5 were taken from a gravelly drainage way at the southeast corner. COSO1603 was composited from 5 grab samples taken from a north-south trending drainage way which bisects the site and receives run-off from the park.	0.5 to 0.6 1.9	COSO1601 COSO1602	Soil	soft, lt. brown, CLAYEY SILT, little grey m-gravel, tr. f-sand	138 to 625 ppm (10.0 eV lamp), 0 ppm (11.7 eV lamp). VOC sample COSO1602 taken adjacent to grab 1(473 ppm). Note that grab 4 (625 ppm) was in gravel and VOC sample could not be obtained. Surface water present at grabs 4 and 5.
		0.7 to 0.8 1.8	COSO1603 COSO1604	Soil	soft, lt. brown, CLAYEY SILT, tr. f-sand, tr. roots and fibers	27 to 1046 ppm (10.0 eV lamp), 0 ppm (11.7 eV lamp) VOC sample COSO1604 taken adjacent to grab 5 (1046 ppm). Surface water present at grabs 1 and 4.
20: D Area	SOUTH DRAINAGE CHANNEL: Area currently operated by Olin to manufacture explosives. Sampling conducted in a grassy drainage channel which receives run-off from a nearby abandoned building. The 5 grab sample locations were spaced approximately evenly along the drainage way.	1.0 to 2.0 1.5	COSO2001 COSO2001	Soil	firm, red-brown, SILTY CLAY, tr. f-sand	Surface water present at grabs 4 and 5. VOC sample also labelled COSO2001 taken adjacent to grab 1 (furthest upstream).

Notes (1) Final sampling depths of grab samples; composite sample grabs are expressed as a range of final depths when applicable.

(2) Composite sample used for description except where indicated with a (3)

(3) Discrete sample used for description

BGS= Below Ground Surface

All headspace measurements are listed as above background. Typically background was less than 2 ppm.

tr.-trace, f-fine, m-medium, c-coarse, lt.-light

(08726592 WB1/arr)

TABLE 3 - FIELD DESCRIPTIONS OF SAMPLES

Site Number	Description	Sampling Depth (1) (ft,BGS)	Investigative Sample Number	Media	Sample Description (2)	Comments
22A : Old Refuge Shop	POST TREATING FACILITY: Sampling was conducted in a relatively flat, grassy open field area adjacent to a complex of buildings being used for storage purposes. This site included 4 investigative sample locations. Each location was an approximately 12 foot square and grabs were obtained at all the corners and in the center. To the immediate west of composite sample location COSO22A01 was the concrete slab of a former building.	0.6 to 0.8	COSO22A03	Soil	soft, dark grey, CLAYEY SILT, some f-m sand, occ. m-gravel	0 ppm (10.6 eV lamp) on all grabs. VOC sample COSO22A03 taken adjacent to grab 1 (soil texture) at NW corner of sampling square.
		1.5 to 2.0	COSO22A04	Soil	firm, brown, SILTY CLAY, and f-sand, occ. m-gravel	
		2.0	COSO22A04			
		0.8 to 1.0	COSO22A01	Soil	soft, brown, CLAYEY SILT, tr. f-sand, tr. roots and fibers	0 ppm (11.7 eV lamp) on all grabs. VOC sample COSO22A06 taken adjacent to grab 5 at center of sampling square.
		2.4 to 2.7	COSO22A02	Soil	soft, brown, CLAYEY SILT, tr. f-sand	
		2.4	COSO22A06			
		1.0 to 1.2	COSO22A07	Soil	soft, brown, CLAYEY SILT, tr. f-sand, tr. f-gravel	0 ppm (11.7 eV lamp) on all grabs. VOC sample COSO22A09 taken adjacent to grab 5 at center of sampling square.
		2.0 to 2.5	COSO22A08	Soil	soft, brown, CLAYEY SILT, tr. f-m sand	
		2.5	COSO22A09			
		1.0 to 1.1	COSO22A10	Soil	soft, brown, CLAYEY SILT, some m-c sand, tr. f-gravel	0 ppm (11.7 eV lamp) on all grabs. VOC sample COSO22A12 taken adjacent to grab 5 at center of sampling square.
		2.2 to 2.5	COSO22A11	Soil	firm, red-brown, CLAYEY SILT, tr. f-c sand	
		2.5	COSO22A12			
36: Area 3 North	WASTE WATER TREATMENT FACILITY: Sampling conducted in the Primary lagoon, west pond, east pond and Dove Creek. Discrete samples collected in the lagoon and ponds. COSL3606 and COSL3607 were obtained from the Primary lagoon. COSL3603 was obtained from the west pond. COSL3604 was obtained from the east pond. Composite sample COSE3601 consisted of 5 grabs taken from locations along Dove Creek.	0.0 to 1.0	COSL3606	Sludge	soft, brown-green, SILTY CLAY, and black organics (3)	Discrete sample taken in Primary Lagoon. Surface water present.
		0.0 to 1.0	COSL3607	Sludge	soft, grey-brown, SILTY CLAY, and black organics (3)	Discrete sample taken in Primary Lagoon. Surface water present.
		0.0 to 1.0	COSL3603	Sludge	soft, brown-grey, SILTY CLAY, and black organics (3)	Discrete sample taken in west pond. Surface water present.
		0.0 to 1.0	COSL3604	Sludge	soft, dark grey-black, SILTY CLAY, and black organics (3)	Discrete sample taken in east pond. Surface water present.
		0.0 to 1.0	COSL3605	Sludge	soft, dark grey-black, SILTY CLAY, and black organics (3)	Discrete sample taken in east pond. Surface water present.
		0.0 to 1.0	COSE3601	Sediment	soft, dark grey, SILTY CLAY, some organics	Surface water present in drainage channel. VOC sample COSE3602 taken adjacent to grab 1 (furthest upstream, discharge pipe).
		1.0	COSE3602			

Notes (1) Final sampling depths of grab samples; composite sample grabs are expressed as a range of final depths when applicable.

(2) Composite sample used for description except where indicated with a (3)

(3) Discrete sample used for description

BGS= Below Ground Surface

All headspace measurements are listed as above background. Typically background was less than 2 ppm.

tr.-trace, f-fine, m-medium, c-coarse, lt.-light

(0872692 WBI/sth)

TABLE 4
QUANTITATION LIMITS FOR TARGET COMPOUND LIST VOCs
IN SOIL, SEDIMENT AND SLUDGE

<u>Analyte</u>	<u>CAS Number</u>	<u>Method Detection Limits (µg/l)</u>	<u>Quantitation Limits¹ (µg/l)</u>
Benzene	71-43-2	1.0	5
Bromdichloromethane	75-27-4	2.0	5
Bromoform	75-25-2	3.0	5
Bromomethane	74-83-9	2.0	10
Carbon Tetrachloride	56-23-5	2.0	5
Chlorobenzene	108-90-7	3.0	5
Chloroethane	75-00-3	1.0	10
Chloroform	67-66-3	5.0	5
Chloromethane	74-87-3	4.0	10
Dibromochloromethane	124-48-1	1.0	5
1,1-Dichloroethane	75-34-3	2.0	5
1,2-Dichloroethane	107-06-2	2.0	5
1,1-Dichloroethene	75-34-4	2.0	5
1,2-Dichloroethene (Total)	--	---	5
1,2-Dichloropropane	78-87-5	1.0	5
cis-1,3-Dichloropropene	10061-01-5	2.0	5
trans-1,3-Dichloropropene	10061-02-6	1.0	5
Ethyl Benzene	100-41-4	2.0	5
Methylene Chloride ²	75-09-2	1.0	10
1,1,2,2-Tetrachloroethane	79-34-5	2.0	5
Tetrachloroethene	127-18-4	2.0	5
Toluene ²	108-88-3	1.0	5
1,1,1-Trichloroethane	71-55-6	3.0	5
1,1,2-Trichloroethane	79-00-5	1.0	5
Trichloroethene	79-01-6	4.0	5
Vinyl Chloride	75-01-4	3.0	10
Acetone ²	67-64-1	10	10
Carbon Disulfide	75-15-0	2.0	5
2-Butanone ²	78-93-3	3.0	10
Vinyl Acetate	108-05-4	1.0	10
4-Methyl-2-Pentanone	108-10-1	2.0	10
2-Hexanone	519-78-6	2.0	10
Styrene	100-42-5	2.0	5
Total Xylenes ³	106-42-3	4	5
2-Chloroethylvinylether	220-75-8	10	10

Notes:

¹ Quantitation limits for VOCs from Pace Laboratories SOP MN-O-446-B. Quantitation limits listed are based on wet-weight. The quantitation limits calculated by the laboratory on a dry-weight basis, as required by the contract, will be higher.

² Common laboratory solvent. Control limits for blanks are five times the method detection limits.

³ m-Xylene, o-Xylene and p-Xylene are reported as a total of the three (total xylenes).

TABLE 5
QUANTITATION LIMITS FOR TARGET COMPOUND LIST SVOCs
IN SOIL, SEDIMENT AND SLUDGE

<u>Analyte</u>	<u>CAS Number</u>	<u>Quantitation Limits¹ µg/kg</u>
Phenol	108-95-2	330
bis(2-Chloroethyl)ether	111-44-4	330
2-Chlorophenol	95-57-8	330
1,3-Dichlorobenzene	541-73-1	330
1,4-Dichlorobenzene	106-46-7	330
Benzyl alcohol	100-51-6	330
1,2-Dichlorobenzene	95-50-1	330
2-Methylphenol	95-48-1	330
bis(2-Chloroisopropyl)ether	108-60-1	330
4-Methylphenol	106-44-5	330
N-Nitroso-di-n-propylamine	621-64-7	330
Hexachloroethane	67-72-1	330
Nitrobenzene	98-95-3	330
Isophorone	78-59-1	330
2-Nitrophenol	88-75-5	330
2,4-Dimethylphenol	105-67-9	330
Benzoic acid	65-85-0	1600
bis(2-Chloroethoxy) methane	111-91-1	330
2,4-Dichlorophenol	120-83-2	330
1,2,4-Trichlorobenzene	120-82-1	330
Naphthalene	91-20-3	330
4-Chloroaniline	106-47-8	330
Hexachlorobutadiene	87-68-3	330
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	330
2-Methylnaphthalene	91-57-6	330
Hexachlorocyclopentadiene	77-47-4	330
2,4,6-Trichlorophenol	88-06-2	330
2,4,5-Trichlorophenol	95-95-4	1600
2-Chloronaphthalene	91-58-7	330
2-Nitroaniline	88-74-4	1600
Dimethylphthalate	131-11-3	330
Acenaphthylene	208-96-8	330
2,6-Dinitrotoluene	606-20-2	330
3-Nitroaniline	99-09-8	1600
Acenaphthene	83-32-9	330
2,4-Dinitrophenol	51-28-5	1600
4-Nitrophenol	100-02-7	1600

TABLE 5 (CONT'D)
 QUANTITATION LIMITS FOR TARGET COMPOUND LIST SVOCs
 IN SOIL, SEDIMENT AND SLUDGE

<u>Analyte</u>	<u>CAS Number</u>	<u>Quantitation Limits¹ μg/kg</u>
Dibenzofuran	132-64-9	330
2,4-Dinitrotoluene	121-14-2	330
Diethylphthalate	84-66-2	330
4-Chlorophenyl phenyl ether	7005-72-3	330
Fluorene	86-73-7	330
4-Nitroaniline	100-01-6	1600
4,6-Dinitro-2-methylphenol	534-52-1	330
N-Nitrosodiphenylamine	86-30-6	330
4-Bromophenyl phenyl ether	101-55-3	330
Hexachlorobenzene	118-74-1	330
Pentachlorophenol	87-86-5	1600
Phenanthrene	85-01-8	330
Anthracene	120-12-7	330
Di-n-butylphthalate	84-74-2	330
Fluoranthene	206-44-0	330
Pyrene	129-00-0	330
Butyl benzyl phthalate	85-68-7	330
3,3-Dichlorobenzidine	91-94-1	660
Benzo(a)anthracene	56-55-3	330
Chrysene	218-01-9	330
bis(2-Ethylhexyl)phthalate	117-81-7	330
Di-n-Octylphthalate	117-84-0	330
Benzo(b)fluoranthene	205-99-2	330
Benzo(k)fluoranthene	207-08-9	330
Benzo(a)pyrene	50-32-8	330
Indeno(1,2,3-cd)pyrene	193-39-5	330
Dibenzo(a,h)anthracene	52-70-3	330
Benzo(g,h,i)perylene	191-24-2	330
N-Nitrosodimethylamine ²	65-75-9	330

¹ Quantitation limits for SVOCs from Pace Laboratories SOP MN-O-436-A. Quantitation limits are based on wet weight. The quantitation limits calculated by the laboratory on a dry-weight basis, as required by the contract, will be higher.

² This compound was added to the analytical program due to site history.

TABLE 6
QUANTITATION LIMITS FOR TARGET COMPOUND LIST PCBs AND PESTICIDES
IN SOIL, SEDIMENT AND SLUDGE

<u>Analyte</u>	<u>CAS Number</u>	<u>Quantitation Limits¹ (µg/kg)</u>
PESTICIDES:		
alpha-BHC	319-84-6	1.7
beta-BHC	319-85-7	1.7
delta-BHC	319-86-8	1.7
gamma-BHC (Lindane)	58-89-9	1.7
Heptachlor	76-44-8	1.7
Aldrin	309-00-2	1.7
Heptachlor epoxide	1024-57-3	1.7
Endosulfan I	959-98-8	1.7
Dieldrin	60-57-1	3.3
4,4'-DDE	72-55-9	3.3
Endrin	72-20-8	3.3
Endosulfan II	33213-65-9	3.3
4,4'-DDD	72-54-8	3.3
Endosulfan sulfate	1031-07-8	3.3
4,4'-DDT	50-29-3	3.3
Methoxychlor	72-43-5	17
Endrin aldehyde	7421-36-3	3.3
alpha-Chlordane	5103-71-9	1.7
gamma-Chlordane	5103-74-2	1.7
Toxaphene	8001-35-2	170
PCBS:		
Aroclor-1016	12674-11-2	30
Aroclor-1221	11104-28-2	30
Aroclor-1232	11141-16-5	30
Aroclor-1242	53469-21-9	30
Aroclor-1248	12672-29-6	30
Aroclor-1254	11097-69-1	30
Aroclor-1260	11096-82-5	30

¹ Quantitation limits for PCB and Pesticide compounds from Pace Laboratories SOP MN-O-447-A. Quantitation limits are based on wet weight. The quantitation limits calculated by the laboratory on a dry-weight basis, as required by the contract, will be higher.

(08721454.wp1\djf)

TABLE 7
REPORTING LIMITS FOR EXPLOSIVES
IN SOILS, SEDIMENTS AND SLUDGE

<u>Analyte</u>	<u>CAS Number</u>	<u>Method Reporting Limit¹</u> <u>(µg/g)</u>
1,3-Dinitrobenzene	99-65-0	249
2,4-Dinitrotoluene	121-14-2	251
2,6-Dinitrotoluene	606-20-2	500
HMX ²	2691-41-0	499
Nitroglycerin	53-63-0	2,500
PETN ³	75-11-5	2,500
RDX ⁴	121-82-4	510
Tetryl ⁵	479-45-8	1.27
1,3,5-Trinitrobenzene	99-35-4	250
2,4,6-Trinitrotoluene	118-96-7	250
2-Nitrotoluene	88-72-2	505
3-Nitrotoluene	99-08-1	245
4-Nitrotoluene	99-99-0	251

Notes:

- ¹ Method reporting limit from Pace Laboratories SOP MN-435-B.
- ² HMX: Octahydro-1,3,5,7-tetranitro-s-tetrazoncine
- ³ PETN: Pentaerythritol tetranitrate
- ⁴ RDX: Hexahydro-1,3,5-trinitro-s-triazine
- ⁵ Tetryl: N-methyl-N,2,4,6-tetranitrobenzenamine

TABLE 8
REPORTING LIMIT FOR DIOXINS AND FURANS
IN SOIL, SEDIMENT AND SLUDGE

<u>Analyte</u>	<u>Reporting Limits¹</u> <u>(µg/kg)</u>
DIOXINS:	
2,3,7,8-TCDD	0.073
1,2,3,7,8-PeCDD	0.13
1,2,3,4,7,8-HxCDD	0.21
1,2,3,6,7,8-HxCDD	0.11
1,2,3,7,8,9-HxCDD	0.18
1,2,3,4,6,7,8-HpCDD	0.21
OCDD	0.28
FURANS:	
2,3,7,8-TCDF	0.064
1,2,3,7,8-PeCDF	0.1
2,3,4,7,8-PeCDF	0.1
1,2,3,4,7,8-HxCDF	0.12
1,2,3,6,7,8-HxCDF	0.092
2,3,4,6,7,8-HxCDF	0.17
1,2,3,7,8,9-HxCDF	0.22
1,2,3,4,6,7,8,-HpCDF	0.17
1,2,3,4,7,8,9-HpCDF	0.19
OCDF	0.35

Notes:

¹ Reporting limits from EPA Method 8280

CDDs: Chlorinated dibenzo-p-dioxins

CDFs: Chlorinated dibenzofurans

T: Tetra

Pe: Penta

Hx: Hexa

Hp: Hepta

O: Octa

(08721456.wp1\djf)

TABLE 9
DETECTION AND QUANTITATION LIMITS FOR TARGET ANALYTE LIST
METALS AND CYANIDE IN SOIL, SEDIMENT AND SLUDGE¹

<u>Analyte</u>	Method Detection Limit ² <u>(µg/kg)</u>	Practical Quantitation Limit <u>(mg/kg)</u>
Aluminum	1.4	20
Antimony	2.0	5.0 ³
Arsenic	8.0	10 ³
Barium	0.3	10
Beryllium	0.5	10
Cadmium	0.5	10
Calcium	4.0	40
Chromium	0.6	50
Cobalt	0.7	7.0
Copper	0.7	7.0
Iron	0.7	7.0
Lead	2.0	5 ³
Magnesium	2.0	50
Manganese	0.6	6
Mercury	0.2	0.2
Nickel	1.5	15
Potassium	4.50	450
Selenium	3.0	50
Silver	0.3	3
Sodium	3.0	50
Thallium	10.0	1.0 ³
Vanadium	0.4	4
Zinc	0.2	2
Cyanide	0.1	1

Notes:

- ¹ The specific SOPs are referenced in the Quality Control Summary Report.
- ² The detection limits for samples may be considerably higher depending on the sample matrix.
- ³ Since the sample required quantitation limit cannot be achieved by using EPA Method 6010, the sample will be analyzed by the appropriate atomic absorption method.

TABLE 10
Summary of Validated TCL Volatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 7		SITE 7A						SITE 8				SITE 9		SITE 10	
Golder Sample ID	COSE0702		COSO07A02		COSC07A04		COSO07A06		COSO07A08		COSO0802		COSO0803		COSE0902	
Laboratory Sample ID	103624		103667		103683		103705		103721		103489		108182		108304	
Sample Depth (feet)	1.9		1.9		1.8		1.8		1.9		1.7		1.6		1.8	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/07/93		05/07/93		05/07/93		05/07/93		05/08/93		05/10/93		05/06/93	
Compound	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg
INDIVIDUAL PARAMETERS																
Acrolein	ND	31	ND	31	ND	30	ND	31	ND	31	ND	31	ND	31	ND	35
Acrylonitrile	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100
INDIVIDUAL PARAMETERS																
Acrolein	ND	31	ND	31	ND	30	ND	31	ND	31	ND	31	ND	31	ND	35
Acrylonitrile	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100
VOLATILES																
Chloromethane	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	6
Bromomethane	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3
Vinyl Chloride	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4
Chloroethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1
Methylene Chloride	10 J(a)	1	2 U	1	6 U	1	14	1	14	1	6 U	1	8	2	4 U	1
Acetone	ND	18	ND	18	ND	18	ND	19	ND	19	70	19	200	40	ND	21
Carbon Disulfide	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
1,1-Dichloroethene	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
1,1-Dichloroethane	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
trans-1,2-Dichloroethene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10	ND	6
Chloroform	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
1,2-Dichloroethane	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
Methyl Ethyl Ketone	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	80	8	ND	4
1,1,1-Trichloroethane	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	8	ND	4
Carbon Tetrachloride	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
Vinyl Acetate	ND	10	ND	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND	10
Bromodichloromethane	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
1,1,2,2-Tetrachloroethane	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
1,2-Dichloropropane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
trans-1,3-Dichloropropene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Trichloroethylene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10	ND	6
Dibromochloromethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
1,1,2-Trichloroethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Benzene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
cis-1,3-Dichloropropene	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
2-Chloroethylvinylether	ND	10	ND	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND	10
Bromoform	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	8	ND	4
2-Hexanone	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
Methyl Isobutyl Ketone	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
Tetrachloroethylene	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
Toluene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Chlorobenzene	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	8	ND	4
Ethylbenzene	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
Styrene	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2	ND	5	ND	3
o-Xylene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10	ND	6
m,p-Xylene (Sum of Isomers)	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	10	ND	6

Notes:

ND -- Not detected at or above the MDL.

MDL -- Method Detection Limit

Conc. -- Concentration (dry-weight basis)

J --- The associated value is an estimated quantity

U --- The associated result is estimated as non-detect.

(a) --- Biased high due to surrogate recovery.

(b) --- Biased low due to surrogate recovery.

(c) --- Estimated due to surrogate recovery related to sample dilution.

(d) --- Biased high due to MS/MSD recovery.

(e) --- Biased low due to MS/MSD recovery.

(f) --- Biased high due to LCS recovery.

(g) --- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard

SO -- Soil / SE-- Sediment / SL-- Sludge

22A -- Site Number

01 -- Sample Number

TABLE 10
Summary of Validated TCL Volatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 10		SITE 11		SITE 11A								SITE 12			
Golder Sample ID	COSE1004		COSO1102		COSO11A05		COSO11A10		COSO11A06		COSO11A07		COSO11A08		COSO1203	
Laboratory Sample ID	109320		109340		109339		109360		109347		109355		109363		93823	
Sample Depth (feet)	1.7		1.3		1.7		1.8		1.7		1.7		1.8		1.8	
Sample Type	Investigative		Investigative		Investigative		Duplicate of COS11A0		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/08/93		05/07/93		05/10/93		05/10/93		05/10/93		05/10/93		05/10/93		04/30/93	
Compound	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg	Conc µg/Kg	MDL µg/Kg
INDIVIDUAL PARAMETERS																
Acrolein	ND	33	ND	32	ND	30	ND	30	ND	31	ND	31	ND	38	ND	31
Acrylonitrile	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	200	ND	100
INDIVIDUAL PARAMETERS																
Acrolein	ND	33	ND	32	ND	30	ND	30	ND	31	ND	31	ND	38	ND	31
Acrylonitrile	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	200	ND	100
VOLATILES																
Chloromethane	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	6	ND	5
Bromomethane	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Vinyl Chloride	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4
Chloroethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Methylene Chloride	8 U	1	ND	1	7	1	10 U	1	6 U	1	8 U	1	17	2	6	1
Acetone	ND	20	280	19	ND	18	ND	18	ND	19	ND	19	52	23	1700	92
Carbon Disulfide	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
1,1-Dichloroethene	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
1,1-Dichloroethane	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
trans-1,2-Dichloroethene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	6	ND	5
Chloroform	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
1,2-Dichloroethane	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Methyl Ethyl Ketone	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4
1,1,1-Trichloroethane	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4
Carbon Tetrachloride	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Vinyl Acetate	ND	10	ND	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND	10
Bromodichloromethane	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
1,1,2,2-Tetrachloroethane	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
1,2-Dichloropropane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
trans-1,3-Dichloropropene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Trichloroethylene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	6	ND	5
Dibromochloromethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
1,1,2-Trichloroethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Benzene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
cis-1,3-Dichloropropene	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
2-Chloroethylvinylether	ND	10	ND	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND	10
Bromoform	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4
2-Hexanone	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Methyl Isobutyl Ketone	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Tetrachloroethylene	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Toluene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	1
Chlorobenzene	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4	ND	4
Ethylbenzene	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
Styrene	ND	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	3	ND	2
o-Xylene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	6	ND	5
m,p-Xylene (Sum of Isomers)	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND	6	ND	5

Notes:

- ND -- Not detected at or above the MDL
MDL -- Method Detection Limit
Conc -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 10
Summary of Validated TCL Volatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 12				SITE 14				SITE 16				SITE 20				SITE 22A			
Golden Sample ID	COSO1204				COSO1402				COSO1602				COSO2001				COSO22A01			
Laboratory Sample ID	93831				100366				100285				90492				93769			
Sample Depth (feet)	1.8				1.5				1.9				1.5				0.8 to 1.0			
Sample Type	Investigative				Investigative				Investigative				Investigative				Investigative			
Sample Date	04/30/93				05/03/93				05/04/93				04/28/93				04/30/93			
Compound	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL	Conc	MDL
	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
INDIVIDUAL PARAMETERS																				
Acrolein	ND	31	ND	4400	ND	35	ND	28	ND	34	ND	32	ND	32	ND	30	ND	31	ND	31
Acrylonitrile	ND	100	ND	17000	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	10	ND	10
INDIVIDUAL PARAMETERS																				
Acrolein	ND	31	ND	4400	ND	35	ND	28	ND	34	ND	32	ND	32	ND	30	ND	31	ND	31
Acrylonitrile	ND	100	ND	17000	ND	100	ND	100	ND	100	ND	100	ND	100	ND	100	ND	10	ND	10
VOLATILES																				
Chloromethane	ND	5	ND	700	ND	6	ND	4	ND	5	ND	10	ND	5	ND	5	ND	5	ND	5
Bromomethane	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Vinyl Chloride	ND	4	ND	540	ND	4	ND	3	ND	4	ND	8	ND	4	ND	4	ND	4	ND	4
Chloroethane	ND	1	ND	170	ND	1	ND	1	ND	1	ND	2	ND	1	ND	1	ND	1	ND	1
Methylene Chloride	6	1	210	170	3 U	1	1 U	1	1 U	1	22 U	2	10 U	1	65	1	6 U	1	6 U	1
Acetone	59	19	ND	2700	88	21	220	17	22	20	370	40	150 U	19	ND	18	65	18	ND	18
Carbon Disulfide	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
1,1-Dichloroethene	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
1,1-Dichloroethane	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
trans-1,2-Dichloroethene	ND	5	ND	700	ND	6	ND	4	ND	5	ND	10	ND	5	ND	5	ND	5	ND	5
Chloroform	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
1,2-Dichloroethane	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Methyl Ethyl Ketone	ND	4	ND	540	7	4	ND	3	ND	4	ND	8	ND	4	ND	4	ND	4	ND	4
1,1,1-Trichloroethane	ND	4	ND	540	ND	4	ND	3	ND	4	ND	8	ND	4	ND	4	ND	4	ND	4
Carbon Tetrachloride	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Vinyl Acetate	ND	10	ND	1700	ND	10	ND	10	ND	10	ND	20	ND	10	ND	10	ND	10	ND	10
Bromodichloromethane	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
1,1,2,2-Tetrachloroethane	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
1,2-Dichloropropane	ND	1	ND	170	ND	1	ND	1	ND	1	ND	2	ND	1	ND	1	ND	1	ND	1
trans-1,3-Dichloropropene	ND	1	ND	170	ND	1	ND	1	ND	1	ND	2	ND	1	ND	1	ND	1	ND	1
Trichloroethylene	ND	5	ND	700	ND	6	ND	4	ND	5	ND	10	ND	5	ND	5	ND	5	ND	5
Dibromochloromethane	ND	1	ND	170	ND	1	ND	1	ND	1	ND	2	ND	1	ND	1	ND	1	ND	1
1,1,2-Trichloroethane	ND	1	ND	170	ND	1	ND	1	ND	1	ND	2	ND	1	ND	1	ND	1	ND	1
Benzene	ND	1	ND	170	ND	1	ND	1	ND	1	ND	2	ND	1	ND	1	ND	1	ND	1
cis-1,3-Dichloropropene	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
2-Chloroethylvinylether	ND	10	ND	1700	ND	10	ND	10	ND	10	ND	20	ND	10	ND	10	ND	10	ND	10
Bromoform	ND	4	ND	540	ND	4	ND	3	ND	4	ND	8	ND	4	ND	4	ND	4	ND	4
2-Hexanone	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Methyl Isobutyl Ketone	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Tetrachloroethylene	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Toluene	11	1	ND	170	ND	1	ND	1	ND	1	ND	2	0	1	ND	1	ND	1	ND	1
Chlorobenzene	ND	4	ND	540	ND	4	ND	3	ND	4	ND	8	ND	4	ND	4	ND	4	ND	4
Ethylbenzene	ND	2	11300	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
Styrene	ND	2	ND	360	ND	3	ND	2	ND	3	ND	5	ND	2	ND	2	ND	2	ND	2
o-Xylene	ND	5	4600	700	ND	6	ND	4	ND	5	ND	10	ND	5	ND	5	ND	5	ND	5
m,p-Xylene (Sum of Isomers)	ND	5	28000	700	ND	6	ND	4	ND	5	ND	10	ND	5	ND	5	ND	5	ND	5

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):
CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 10
Summary of Validated TCL Volatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 22A										SITE 36							
Golden Sample ID	COSO22A04		COSO22A09		COSO22A14		COSO22A12		COSO22A03		COSE3602		COSE3610		COSL3603		COSL3604	
Laboratory Sample ID	93416		95257		95273		95265		93424		103403		103535		100323		100331	
Sample Depth (feet)	2.0		2.5		2.5		2.5		0.6 to 0.8		1.0		1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Duplicate of COSO22		Investigative		Investigative		Investigative		Duplicate of COSE360		Investigative		Investigative	
Sample Date	04/29/93		04/29/93		05/03/93		05/03/93		04/29/93		05/06/93		05/06/93		05/05/93		05/05/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
INDIVIDUAL PARAMETERS																		
Acrolein	ND	32	ND	33	ND	32	ND	32	ND	31	ND	44	ND	200	ND	33	ND	8600
Acrylonitrile	ND	100	ND	100	ND	100	ND	100	ND	100	ND	200	ND	38	ND	100	ND	33000
INDIVIDUAL PARAMETERS																		
Acrolein	ND	32	ND	33	ND	32	ND	32	ND	31	ND	44	ND	200	ND	33	ND	8600
Acrylonitrile	ND	100	ND	100	ND	100	ND	100	ND	100	ND	200	ND	38	ND	100	ND	33000
VOLATILES																		
Chloromethane	ND	5	ND	5	ND	5	ND	5	ND	5	ND	7	ND	6	ND	5	ND	3000
Bromomethane	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Vinyl Chloride	ND	4	ND	4	ND	4	ND	4	ND	4	ND	5	ND	4	ND	4	ND	2080
Chloroethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
Methylene Chloride	2 U	1	1 U	1	1 U	1	1 U	1	6 UJ(a)	1	ND	2	4 U	2	1 U	1	800	690
Acetone	ND	19	ND	20	31	19	230	19	ND	19	93	26	95	23	109	20	ND	10600
Carbon Disulfide	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
1,1-Dichloroethane	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
1,1-Dichloroethane	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
trans-1,2-Dichloroethane	ND	5	ND	5	ND	5	ND	5	ND	5	ND	7	ND	6	ND	5	ND	3000
Chloroform	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
1,2-Dichloroethane	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Methyl Ethyl Ketone	ND	4	ND	4	ND	4	5	4	ND	4	ND	5	ND	4	ND	4	ND	2080
1,1,1-Trichloroethane	ND	4	ND	4	ND	4	ND	4	ND	4	ND	5	ND	4	ND	4	ND	2080
Carbon Tetrachloride	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Vinyl Acetate	ND	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND	20	ND	10	ND	6900
Bromodichloromethane	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
1,1,2,2-Tetrachloroethane	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
1,2-Dichloropropane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
trans-1,3-Dichloropropene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
Trichloroethylene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	7	ND	6	ND	5	ND	3000
Dibromochloromethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
1,1,2-Trichloroethane	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
Benzene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
cis-1,3-Dichloropropene	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
2-Chloroethylvinylether	ND	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND	20	ND	10	ND	6900
Bromoform	ND	4	ND	4	ND	4	ND	4	ND	4	ND	5	ND	4	ND	4	ND	2080
2-Hexanone	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Methyl Isobutyl Ketone	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Tetrachloroethylene	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Toluene	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2	ND	1	ND	690
Chlorobenzene	ND	4	ND	4	ND	4	ND	4	ND	4	ND	5	ND	4	ND	4	ND	2080
Ethylbenzene	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
Styrene	ND	2	ND	3	ND	2	ND	2	ND	2	ND	4	ND	3	ND	3	ND	1400
o-Xylene	ND	5	ND	5	ND	5	ND	5	ND	5	ND	7	ND	6	ND	5	ND	3000
m,p-Xylene (Sum of Isomers)	ND	5	ND	5	ND	5	ND	5	ND	5	ND	7	ND	6	ND	5	ND	3000

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery
(c) -- Estimated due to surrogate recovery related to sample dilution
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 10

Summary of Validated TCL Volatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion Illinois

Site	SITE 36					
Location						
Golder Sample ID	COSL3605		COSL3606		COSL3607	
Laboratory Sample ID	100340		100269		100250	
Sample Depth (feet)	0.0 to 1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Investigative	
Sample Date	05/05/93		05/04/93		05/04/93	
Compound	Conc	MDL	Conc	MDL	Conc	MDL
	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
INDIVIDUAL PARAMETERS						
Acrolein	ND	61	ND	35	ND	38
Acrylonitrile	ND	200	ND	100	ND	200
INDIVIDUAL PARAMETERS						
Acrolein	ND	61	ND	35	ND	38
Acrylonitrile	ND	200	ND	100	ND	200
VOLATILES						
Chloromethane	ND	50	ND	6	ND	6
Bromomethane	ND	20	ND	3	ND	3
Vinyl Chloride	ND	36	ND	4	ND	4
Chloroethane	ND	12	ND	1	ND	2
Methylene Chloride	ND	12	3 U	1	2 U	2
Acetone	880	183	40	21	68	23
Carbon Disulfide	ND	20	ND	3	ND	3
1,1-Dichloroethene	ND	20	ND	3	ND	3
1,1-Dichloroethane	ND	20	ND	3	ND	3
trans-1,2-Dichloroethene	ND	50	ND	6	ND	6
Chloroform	ND	20	ND	3	ND	3
1,2-Dichloroethane	ND	20	ND	3	ND	3
Methyl Ethyl Ketone	161	36	ND	4	ND	4
1,1,1-Trichloroethane	ND	36	ND	4	ND	4
Carbon Tetrachloride	ND	20	ND	3	ND	3
Vinyl Acetate	ND	120	ND	10	ND	20
Bromodichloromethane	ND	20	ND	3	ND	3
1,1,2,2-Tetrachloroethane	ND	20	ND	3	ND	3
1,2-Dichloropropane	ND	12	ND	1	ND	2
trans-1,3-Dichloropropene	ND	12	ND	1	ND	2
Trichloroethylene	ND	50	ND	6	ND	6
Dibromochloromethane	ND	12	ND	1	ND	2
1,1,2-Trichloroethane	ND	12	ND	1	ND	2
Benzene	ND	12	ND	1	ND	2
cis-1,3-Dichloropropene	ND	20	ND	3	ND	3
2-Chloroethylvinylether	ND	120	ND	10	ND	20
Bromoform	ND	36	ND	4	ND	4
2-Hexanone	ND	20	ND	3	ND	3
Methyl Isobutyl Ketone	ND	20	ND	3	ND	3
Tetrachloroethylene	ND	20	ND	3	ND	3
Toluene	ND	12	ND	1	ND	2
Chlorobenzene	ND	36	ND	4	ND	4
Ethylbenzene	ND	20	ND	3	ND	3
Styrene	ND	20	ND	3	ND	3
o-Xylene	61	50	ND	6	ND	6
m,p-Xylene (Sum of isomers)	58	50	ND	6	ND	6

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution
(d) -- Biased high due to MS/MSD recovery
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (C
CO -- Crab Orchard
SO -- Soil / SE-- Sedi
22A -- Site Number
01 -- Sample Number

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 7		SITE 7A				SITE 8		SITE 9		SITE 10			
Goldier Sample ID	COSE0701		COSO07A01		COSO07A03		COSO07A05		COSO07A07		COSO0801		COSE0901	
Laboratory Sample ID	103608		103659		103675		103691		103713		103454		103497	
Sample Depth (feet)	1.7 to 1.8		1.4		1.5 to 1.6		1.6 to 1.7		1.5		1.6 to 1.7		2.0 to 2.1	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/07/93		05/07/93		05/07/93		05/07/93		06/08/93		06/08/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
INDIVIDUAL PARAMETERS														
Carbazole	ND	410	ND	410	ND	400	ND	410	ND	410	ND	330	ND	440
n-Nitrosodimethylamine	ND	410	ND	410	ND	400	ND	410	ND	410	ND	330	ND	440
SEMIVOLATILE ORGANICS														
Phenol	ND	84	ND	84	ND	82	ND	85	ND	85	ND	68	ND	91
bis(2-Chloroethyl)ether	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	ND	121
2-Chlorophenol	ND	160	ND	160	ND	160	ND	160	ND	160	ND	130	ND	170
1,3-Dichlorobenzene	ND	80	ND	80	ND	78	ND	81	ND	81	ND	65	ND	87
1,4-Dichlorobenzene	ND	86	ND	86	ND	84	ND	88	ND	88	ND	70	ND	93
1,2-Dichlorobenzene	ND	84	ND	84	ND	82	ND	85	ND	85	ND	68	ND	91
2-Methylphenol	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	160
bis(2-Chloroisopropyl)ether	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	ND	121
4-Methylphenol	ND	53	ND	53	ND	52	ND	54	ND	54	ND	43	ND	57
n-Nitrosodi-n-propylamine	ND	99	ND	99	ND	96	ND	100	ND	100	ND	80	ND	107
Hexachloroethane	ND	69	ND	69	ND	67	ND	70	ND	70	ND	56	ND	75
Nitrobenzene	ND	140	ND	140	ND	130	ND	140	ND	140	ND	110	ND	150
Isophorone	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	160
2-Nitrophenol	ND	280	ND	280	ND	280	ND	280	ND	280	ND	230	ND	310
2,4-Dimethylphenol	ND	200	ND	200	ND	190	ND	200	ND	200	ND	160	ND	210
bis(2-Chloroethoxy)methane	ND	180	ND	180	ND	180	ND	190	ND	190	ND	150	ND	200
2,4-Dichlorophenol	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	240
1,2,4-Trichlorobenzene	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	ND	121
Naphthalene	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	ND	121
4-Chloroaniline	ND	340	ND	340	ND	340	ND	350	ND	350	ND	280	ND	370
Hexachlorobutadiene	ND	102	ND	102	ND	100	ND	104	ND	104	ND	83	ND	111
4-Chloro-3-methylphenol	ND	200	ND	200	ND	190	ND	200	ND	200	ND	160	ND	210
2-Methylnaphthalene	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	240
Hexachlorocyclopentadiene	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	160
2,4,6-Trichlorophenol	ND	180	ND	180	ND	180	ND	190	ND	190	ND	150	ND	200
2,4,5-Trichlorophenol	ND	100	ND	100	ND	98	ND	101	ND	101	ND	81	ND	108
2-Chloronaphthalene	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	ND	121
2-Nitroaniline	ND	270	ND	270	ND	260	ND	280	ND	280	ND	220	ND	290
Dimethyl phthalate	ND	80	ND	80	ND	78	ND	81	ND	81	ND	65	ND	87
Acenaphthylene	ND	92	ND	92	ND	90	ND	94	ND	94	ND	75	ND	100
3-Nitroaniline	ND	340	ND	340	ND	340	ND	350	ND	350	ND	280	ND	370
Acenaphthene	ND	100	ND	100	ND	98	ND	101	ND	101	ND	81	ND	108
2,4-Dinitrophenol	ND	62	ND	62	ND	60	ND	62	ND	62	ND	50	ND	67
4-Nitrophenol	ND	63	ND	63	ND	61	ND	64	ND	64	ND	51	ND	68
Dibenzofuran	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	240

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 7		SITE 7A				SITE 8		SITE 9		SITE 10			
Golden Sample ID	COSE0701		COSO07A01		COSO07A03		COSO07A05		COSO07A07		COSO0801		COSE0901	
Laboratory Sample ID	103608		103650		103675		103691		103713		103454		103497	
Sample Depth (feet)	1.7 to 1.8		1.4		1.5 to 1.6		1.6 to 1.7		1.5		1.6 to 1.7		2.0 to 2.1	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/07/93		05/07/93		05/07/93		05/07/93		06/08/93		06/08/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
2,4-Dinitrotoluene	ND	92	ND	92	ND	90	ND	94	ND	94	ND	75	ND	106
2,6-Dinitrotoluene	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	ND	126
Diethyl phthalate	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	170
4-Chlorophenyl phenyl ether	ND	120	ND	120	ND	120	ND	120	ND	120	ND	100	ND	140
Fluorene	ND	100	ND	100	ND	98	ND	101	ND	101	ND	81	ND	114
4-Nitroaniline	ND	750	ND	750	ND	730	ND	760	ND	760	ND	610	ND	860
2-methyl-4,6-dinitrophenol	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	250
n-Nitrosodiphenylamine	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	170
4-Bromophenyl phenyl ether	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	170
Hexachlorobenzene	ND	150	ND	150	ND	140	ND	150	ND	150	ND	120	ND	170
Pentachlorophenol	ND	990	ND	990	ND	990	ND	1000	ND	1000	ND	800	ND	1130
Phenanthrene	ND	120	ND	120	ND	120	ND	120	ND	120	ND	100	450	140
Anthracene	ND	120	ND	120	ND	120	ND	120	ND	120	ND	100	ND	140
Di-n-butyl phthalate	ND	120	ND	120	ND	120	ND	120	ND	120	ND	100	ND	140
Fluoranthene	ND	112	ND	112	ND	110	ND	114	ND	114	ND	91	690	128
Pyrene	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	510	250
Butyl benzyl phthalate	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	250
3,3-Dichlorobenzidine	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	250
Benzo(a)anthracene	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	250	250
bis(2-Ethylhexyl)phthalate	ND	370	ND	370	ND	360	ND	360	ND	360	ND	300	360	420
Chrysene	ND	250	ND	250	ND	240	ND	250	ND	250	ND	200	ND	260
Di-n-octyl phthalate	ND	200	ND	200	ND	190	ND	200	ND	200	ND	160	ND	220
Benzo(b)fluoranthene	ND	210	ND	210	ND	200	ND	210	ND	210	ND	170	340	240
Benzo(k)fluoranthene	ND	410	ND	410	ND	400	ND	410	ND	410	ND	330	ND	460
Benzo(a)pyrene	ND	220	ND	220	ND	220	ND	220	ND	220	ND	180	ND	250
Indeno(1,2,3-c,d)pyrene	ND	200	ND	200	ND	190	ND	200	ND	200	ND	160	ND	220
Dibenzo(a,h)anthracene	ND	81	ND	81	ND	80	ND	82	ND	82	ND	66	ND	93
Benzo(g,h,i)perylene	ND	200	ND	200	ND	190	ND	200	ND	200	ND	160	ND	220

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE -- Sediment / SL -- Sludge
22A -- Site Number
01 -- Sample Number

Created: SK
Reviewed: RP
Checked: MD

TABLE 11
Summary of TCL Validated Semi-volatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site	SITE 11		SITE 11A						SITE 12					
Location														
Golden Sample ID	COSO1101		COSO11A01		COSO11A09		COSO11A02		COSO11A03		COSO11A04		COSO1201	
Laboratory Sample ID	103632		107875		108138		107863		107930		107948		93807	
Sample Depth (feet)	1.7 to 1.9		1.5 to 1.6		1.5 to 1.6		1.7 to 1.9		1.7 to 1.8		1.7 to 1.8		1.8 to 2.2	
Sample Type	Investigative		Investigative		Duplicate of COS11A01		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/10/93		05/10/93		05/10/93		05/10/93		05/10/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
INDIVIDUAL PARAMETERS														
Carbazole	ND	420	ND	400	ND	390	ND	410	ND	410	ND	500	ND	410
n-Nitrosodimethylamine	ND	420	ND	400	ND	390	ND	410	ND	410	ND	500	ND	410
SEMI-VOLATILE ORGANICS														
Phenol	ND	86	ND	83	ND	81	ND	85	ND	85	ND	103	ND	84
bis(2-Chloroethyl)ether	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
2-Chlorophenol	ND	160	ND	160	ND	150	ND	160	ND	160	ND	200	ND	160
1,3-Dichlorobenzene	ND	82	ND	79	ND	77	ND	81	ND	81	ND	98	ND	80
1,4-Dichlorobenzene	ND	89	ND	85	ND	83	ND	88	ND	88	ND	106	ND	86
1,2-Dichlorobenzene	ND	86	ND	83	ND	81	ND	85	ND	85	ND	103	ND	84
2-Methylphenol	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
bis(2-Chloroisopropyl)ether	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
4-Methylphenol	ND	54	ND	52	ND	51	ND	54	ND	54	ND	65	ND	53
n-Nitrosodi-n-propylamine	ND	101	ND	98	ND	95	ND	100	ND	100	ND	121	ND	99
Hexachloroethane	ND	71	ND	68	ND	67	ND	70	ND	70	ND	85	ND	69
Nitrobenzene	ND	140	ND	130	ND	130	ND	140	ND	140	ND	170	ND	140
Isophorone	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
2-Nitrophenol	ND	290	ND	280	ND	270	ND	290	ND	290	ND	350	ND	280
2,4-Dimethylphenol	ND	200	ND	200	ND	190	ND	200	ND	200	ND	240	ND	200
bis(2-Chloroethoxy)methane	ND	190	ND	180	ND	180	ND	190	ND	190	ND	230	ND	180
2,4-Dichlorophenol	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
1,2,4-Trichlorobenzene	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
Naphthalene	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
4-Chloroaniline	ND	350	ND	340	ND	330	ND	350	ND	350	ND	420	ND	340
Hexachlorobutadiene	ND	105	ND	101	ND	99	ND	104	ND	104	ND	126	ND	102
4-Chloro-3-methylphenol	ND	200	ND	200	ND	190	ND	200	ND	200	ND	240	ND	200
2-Methylnaphthalene	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
Hexachlorocyclopentadiene	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
2,4,6-Trichlorophenol	ND	190	ND	180	ND	180	ND	190	ND	190	ND	230	ND	180
2,4,5-Trichlorophenol	ND	102	ND	99	ND	96	ND	101	ND	101	ND	123	ND	100
2-Chloronaphthalene	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
2-Nitroaniline	ND	280	ND	270	ND	260	ND	280	ND	280	ND	330	ND	270
Dimethyl phthalate	ND	82	ND	79	ND	77	ND	81	ND	81	ND	98	ND	80
Acenaphthylene	ND	95	ND	91	ND	89	ND	94	ND	94	ND	114	ND	92
3-Nitroaniline	ND	350	ND	340	ND	330	ND	350	ND	350	ND	420	ND	340
Acenaphthene	ND	102	ND	99	ND	96	ND	101	ND	101	ND	123	ND	100
2,4-Dinitrophenol	ND	63	ND	61	ND	60	ND	62	ND	62	ND	76	ND	62
4-Nitrophenol	ND	64	ND	62	ND	61	ND	64	ND	64	ND	77	ND	63
Dibenzofuran	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 11		SITE 11A						SITE 12					
Golden Sample ID	COSO1101		COSO11A01		COSO11A09		COSO11A02		COSO11A03		COSO11A04		COSO1201	
Laboratory Sample ID	103632		107875		108138		107883		107930		107948		93807	
Sample Depth (feet)	1.7 to 1.9		1.5 to 1.6		1.5 to 1.6		1.7 to 1.9		1.7 to 1.8		1.7 to 1.8		1.8 to 2.2	
Sample Type	Investigative		Investigative		Duplicate of COS11A01		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/10/93		05/10/93		05/10/93		05/10/93		05/10/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
2,4-Dinitrotoluene	ND	95	ND	91	ND	89	ND	94	ND	94	ND	114	ND	92
2,6-Dinitrotoluene	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
Diethyl phthalate	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
4-Chlorophenyl phenyl ether	ND	130	ND	120	ND	120	ND	120	ND	120	ND	150	ND	120
Fluorene	ND	102	ND	99	ND	96	ND	101	ND	101	ND	123	ND	100
4-Nitroaniline	ND	770	ND	740	ND	730	ND	780	ND	780	ND	920	ND	750
2-methyl-4,6-dinitrophenol	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
n-Nitrosodiphenylamine	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
4-Bromophenyl phenyl ether	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
Hexachlorobenzene	ND	150	ND	150	ND	140	ND	150	ND	150	ND	180	ND	150
Pentachlorophenol	ND	1010	ND	980	ND	950	ND	1000	ND	1000	ND	1210	ND	990
Phenanthrene	ND	130	ND	120	ND	120	ND	120	ND	120	ND	150	ND	120
Anthracene	ND	130	ND	120	ND	120	ND	120	ND	120	ND	150	ND	120
Di-n-butyl phthalate	ND	130	ND	120	ND	120	ND	120	ND	120	ND	150	ND	120
Fluoranthene	ND	115	ND	111	ND	108	ND	114	ND	114	ND	138	ND	112
Pyrene	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
Butyl benzyl phthalate	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
3,3-Dichlorobenzidine	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
Benzo(a)anthracene	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
bis(2-Ethylhexyl)phthalate	ND	380	ND	360	ND	360	ND	380	ND	380	ND	450	ND	370
Chrysene	ND	250	ND	240	ND	240	ND	250	ND	250	ND	300	ND	250
Di-n-octyl phthalate	ND	200	ND	200	ND	190	ND	200	ND	200	ND	240	ND	200
Benzo(b)fluoranthene	ND	220	ND	210	ND	200	ND	210	ND	210	ND	260	ND	210
Benzo(k)fluoranthene	ND	420	ND	400	ND	390	ND	410	ND	410	ND	500	ND	410
Benzo(a)pyrene	ND	230	ND	220	ND	210	ND	220	ND	220	ND	270	ND	220
Indeno(1,2,3-c,d)pyrene	ND	200	ND	200	ND	190	ND	200	ND	200	ND	240	ND	200
Dibenz(a,h)anthracene	ND	84	ND	80	ND	78	ND	82	ND	82	ND	100	ND	81
Benzo(g,h,i)perylene	ND	200	ND	200	ND	190	ND	200	ND	200	ND	240	ND	200

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)

Sample ID Breakdown: (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE -- Sediment / SL -- Sludge
22A -- Site Number
01 -- Sample Number

Created: SK
Reviewed: RP
Checked: MD

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 14				SITE 16				SITE 20				SITE 22A			
Golden Sample ID	COSO1401		COSO1403		COSO1601		COSO1603		COSO2001		COSO2002		COSO22A01		COSO22A02	
Laboratory Sample ID	100358		100374		100277		100293		90492		90506		93769		93777	
Sample Depth (feet)	1.4 to 1.5		1.4 to 1.5		0.5 to 0.6		0.7 to 0.8		1.0 to 2.0		1.0 to 2.0		0.8 to 1.0		2.4 to 2.7	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Duplicate of COSO2002		Investigative		Investigative	
Sample Date	05/03/93		05/05/93		05/04/93		05/04/93		04/28/93		04/28/93		04/30/93		04/30/93	
Compound	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg
INDIVIDUAL PARAMETERS																
Carbazole	ND	470	ND	460	ND	380	ND	440	ND	420	ND	420	ND	400	ND	410
n-Nitrosodimethylamine	ND	470	ND	460	ND	380	ND	440	ND	420	ND	420	ND	400	ND	410
SEMIVOLATILE ORGANICS																
Phenol	ND	97	ND	94	ND	77	ND	92	ND	87	ND	87	ND	83	ND	85
bis(2-Chloroethyl)ether	ND	130	ND	126	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
2-Chlorophenol	ND	180	ND	180	ND	150	ND	180	ND	170	ND	170	ND	160	ND	160
1,3-Dichlorobenzene	ND	93	ND	90	ND	74	ND	88	ND	83	ND	83	ND	79	ND	81
1,4-Dichlorobenzene	ND	100	ND	97	ND	80	ND	94	ND	90	ND	90	ND	85	ND	88
1,2-Dichlorobenzene	ND	97	ND	94	ND	77	ND	92	ND	87	ND	87	ND	83	ND	85
2-Methylphenol	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
bis(2-Chloroisopropyl)ether	ND	130	ND	126	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
4-Methylphenol	ND	61	ND	60	ND	49	ND	58	ND	55	ND	55	ND	52	ND	54
n-Nitrosodi-n-propylamine	ND	114	ND	111	ND	91	ND	108	ND	102	ND	102	ND	98	ND	100
Hexachloroethane	ND	80	ND	78	ND	64	ND	76	ND	72	ND	72	ND	68	ND	70
Nitrobenzene	ND	160	ND	150	ND	120	ND	150	ND	140	ND	140	ND	130	ND	140
Isophorone	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
2-Nitrophenol	ND	330	ND	320	ND	260	ND	310	ND	290	ND	290	ND	280	ND	290
2,4-Dimethylphenol	ND	230	ND	220	ND	180	ND	220	ND	200	ND	200	ND	200	ND	200
bis(2-Chloroethoxy)methane	ND	210	ND	210	ND	170	ND	200	ND	190	ND	190	ND	180	ND	180
2,4-Dichlorophenol	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
1,2,4-Trichlorobenzene	ND	130	ND	126	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
Naphthalene	ND	130	ND	126	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
4-Chloroaniline	ND	400	ND	390	ND	320	ND	360	ND	360	ND	360	ND	340	ND	350
Hexachlorobutadiene	ND	118	ND	115	ND	94	ND	112	ND	106	ND	106	ND	101	ND	104
4-Chloro-3-methylphenol	ND	230	ND	220	ND	180	ND	220	ND	200	ND	200	ND	200	ND	200
2-Methylnaphthalene	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
Hexachlorocyclopentadiene	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
2,4,6-Trichlorophenol	ND	210	ND	210	ND	170	ND	200	ND	190	ND	190	ND	180	ND	180
2,4,5-Trichlorophenol	ND	116	ND	112	ND	92	ND	109	ND	104	ND	104	ND	99	ND	101
2-Chloronaphthalene	ND	130	ND	126	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
2-Nitroaniline	ND	310	ND	300	ND	250	ND	300	ND	280	ND	280	ND	270	ND	280
Dimethyl phthalate	ND	93	ND	90	ND	74	ND	88	ND	83	ND	83	ND	79	ND	81
Acenaphthylene	ND	107	ND	104	ND	85	ND	101	ND	96	ND	96	ND	91	ND	94
3-Nitroaniline	ND	400	ND	390	ND	320	ND	360	ND	360	ND	360	ND	340	ND	350
Acenaphthene	ND	118	ND	112	ND	92	ND	109	ND	104	ND	104	ND	99	ND	101
2,4-Dinitrophenol	ND	71	ND	69	ND	57	ND	66	ND	64	ND	64	ND	61	ND	62
4-Nitrophenol	ND	73	ND	71	ND	58	ND	69	ND	65	ND	65	ND	62	ND	64
Dibenzofuran	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 14				SITE 16				SITE 20				SITE 22A			
Golden Sample ID	COSO1401		COSO1403		COSO1601		COSO1603		COSO2001		COSO2002		COSO22A01		COSO22A02	
Laboratory Sample ID	100358		100374		100277		100283		90492		90506		93769		93777	
Sample Depth (feet)	1.4 to 1.5		1.4 to 1.5		0.5 to 0.6		0.7 to 0.8		1.0 to 2.0		1.0 to 2.0		0.8 to 1.0		2.4 to 2.7	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Duplicate of COSO2002		Investigative		Investigative	
Sample Date	05/03/93		05/05/93		05/04/93		05/04/93		04/28/93		04/28/93		04/30/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
2,4-Dinitrotoluene	ND	107	ND	104	ND	85	ND	101	ND	98	ND	96	ND	91	ND	94
2,6-Dinitrotoluene	ND	130	ND	128	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
Diethyl phthalate	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
4-Chlorophenyl phenyl ether	ND	140	ND	140	ND	110	ND	140	ND	130	ND	130	ND	120	ND	120
Fluorene	ND	116	ND	112	ND	92	ND	109	ND	104	ND	104	ND	99	ND	101
4-Nitroaniline	ND	870	ND	850	ND	690	ND	820	ND	780	ND	780	ND	740	ND	760
2-methyl-4,6-dinitrophenol	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
n-Nitrosodiphenylamine	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
4-Bromophenyl phenyl ether	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
Hexachlorobenzene	ND	170	ND	170	ND	140	ND	160	ND	150	ND	150	ND	150	ND	150
Pentachlorophenol	ND	1140	ND	1110	ND	910	ND	1080	ND	1190	ND	1190	ND	980	ND	1000
Phenanthrene	ND	140	ND	140	ND	110	ND	140	ND	130	ND	130	ND	120	ND	120
Anthracene	ND	140	ND	140	ND	110	ND	140	ND	130	ND	130	ND	120	ND	120
Di-n-butyl phthalate	310	140	ND	140	ND	110	ND	140	ND	130	ND	130	ND	120	ND	120
Fluoranthene	ND	130	ND	128	ND	103	ND	123	ND	117	ND	117	ND	111	ND	114
Pyrene	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
Butyl benzyl phthalate	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
3,3-Dichlorobenzidine	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
Benzo(a)anthracene	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
bis(2-Ethylhexyl)phthalate	ND	430	ND	420	ND	340	ND	400	ND	380	ND	330	ND	360	ND	380
Chrysene	ND	280	ND	280	ND	230	ND	270	ND	260	ND	260	ND	240	ND	250
Di-n-octyl phthalate	ND	230	ND	220	ND	180	ND	220	ND	200	ND	200	ND	200	ND	200
Benzo(b)fluoranthene	ND	240	ND	240	ND	190	ND	230	ND	220	ND	220	ND	210	ND	210
Benzo(k)fluoranthene	ND	470	ND	460	ND	380	ND	440	ND	740	ND	740	ND	400	ND	410
Benzo(a)pyrene	ND	260	ND	250	ND	200	ND	240	ND	230	ND	230	ND	220	ND	220
Indeno(1,2,3-c,d)pyrene	ND	230	ND	220	ND	180	ND	220	ND	200	ND	200	ND	200	ND	200
Dibenzo(a,h)anthracene	ND	94	ND	92	ND	75	ND	89	ND	85	ND	85	ND	80	ND	82
Benzo(g,h,i)perylene	ND	230	ND	220	ND	180	ND	220	ND	200	ND	200	ND	200	ND	200

Notes:

ND -- Not detected at or above the MDL
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE -- Sediment / SL -- Sludge
22A -- Site Number
01 -- Sample Number

Created: SK
Reviewed: RP
Checked: MD

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location Golder Sample ID Laboratory Sample ID Sample Depth (feet) Sample Type Sample Date	SITE 22A										SITE 36					
	COSO22A04 93416 1.5 to 2.0 Investigative 04/29/93	COSO22A07 95206 1.0 to 1.2 Investigative 05/03/93	COSO22A08 95214 2.0 to 2.5 Investigative 05/03/93	COSO22A13 95249 2.0 to 2.5 Duplicate of COSO22A08 05/03/93	COSO22A10 95222 1.0 to 1.1 Investigative 05/03/93	COSO22A11 95230 2.2 to 2.5 Investigative 05/03/93	COSE3601 103357 1.0 to 1.5 Investigative 06/09/93	COSE3609 103438 1.0 to 1.5 Duplicate of COSE3601 06/09/93	COSL3603 100323 0.0 to 1.0 Investigative 05/05/93							
Compound	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg
INDIVIDUAL PARAMETERS																
Carbazole	ND	420	ND	430	ND	430	ND	430	ND	460	ND	420	ND	330	ND	440
n-Nitrosodimethylamine	ND	420	ND	430	ND	430	ND	430	ND	460	ND	420	ND	330	ND	440
SEMIVOLATILE ORGANICS																
Phenol	ND	86	ND	89	ND	89	ND	88	ND	96	ND	87	ND	68	ND	91
bis(2-Chloroethyl)ether	ND	115	ND	120	ND	120	ND	118	ND	128	ND	117	ND	91	ND	121
2-Chlorophenol	ND	160	ND	170	ND	170	ND	170	ND	180	ND	170	ND	130	ND	170
1,3-Dichlorobenzene	ND	82	ND	86	ND	86	ND	84	ND	92	ND	83	ND	65	ND	87
1,4-Dichlorobenzene	ND	89	ND	92	ND	92	ND	91	ND	98	ND	90	ND	70	ND	93
1,2-Dichlorobenzene	ND	86	ND	89	ND	89	ND	88	ND	96	ND	87	ND	68	ND	91
2-Methylphenol	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	160
bis(2-Chloroisopropyl)ether	ND	115	ND	120	ND	120	ND	118	ND	128	ND	117	ND	91	ND	121
4-Methylphenol	ND	54	ND	56	ND	56	ND	56	ND	60	ND	55	ND	43	ND	57
n-Nitrosodi-n-propylamine	ND	101	ND	105	ND	105	ND	104	ND	113	ND	102	ND	80	ND	107
Hexachloroethane	ND	71	ND	74	ND	74	ND	73	ND	79	ND	72	ND	56	ND	75
Nitrobenzene	ND	140	ND	140	ND	140	ND	140	ND	150	ND	140	ND	110	ND	150
Isophorone	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	160
2-Nitrophenol	ND	290	ND	300	ND	300	ND	300	ND	320	ND	290	ND	230	ND	310
2,4-Dimethylphenol	ND	200	ND	210	ND	210	ND	210	ND	220	ND	200	ND	160	ND	210
bis(2-Chloroethoxy)methane	ND	190	ND	200	ND	200	ND	190	ND	210	ND	190	ND	150	ND	200
2,4-Dichlorophenol	ND	230	ND	240	ND	240	ND	230	ND	250	ND	230	ND	180	ND	240
1,2,4-Trichlorobenzene	ND	115	ND	120	ND	120	ND	118	ND	128	ND	117	ND	91	ND	121
Naphthalene	ND	115	ND	120	ND	120	ND	118	ND	128	ND	117	ND	91	ND	121
4-Chloroaniline	ND	350	ND	370	ND	370	ND	360	ND	390	ND	360	ND	280	ND	370
Hexachlorobutadiene	ND	105	ND	109	ND	109	ND	108	ND	117	ND	108	ND	83	ND	111
4-Chloro-3-methylphenol	ND	200	ND	210	ND	210	ND	210	ND	220	ND	200	ND	160	ND	210
2-Methylnaphthalene	ND	230	ND	240	ND	240	ND	230	ND	250	ND	230	ND	180	ND	240
Hexachlorocyclopentadiene	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	160
2,4,6-Trichlorophenol	ND	190	ND	200	ND	200	ND	190	ND	210	ND	190	ND	150	ND	200
2,4,5-Trichlorophenol	ND	102	ND	106	ND	106	ND	105	ND	114	ND	104	ND	81	ND	108
2-Chloronaphthalene	ND	115	ND	120	ND	120	ND	118	ND	128	ND	117	ND	91	ND	121
2-Nitroaniline	ND	280	ND	290	ND	290	ND	280	ND	310	ND	280	ND	220	ND	290
Dimethyl phthalate	ND	82	ND	86	ND	86	ND	84	ND	92	ND	83	ND	65	ND	87
Acenaphthylene	ND	95	ND	99	ND	99	ND	97	ND	106	ND	96	ND	75	ND	100
3-Nitroaniline	ND	350	ND	370	ND	370	ND	360	ND	390	ND	360	ND	280	ND	370
Acenaphthene	ND	102	ND	106	ND	106	ND	105	ND	114	ND	104	ND	81	ND	108
2,4-Dinitrophenol	ND	63	ND	66	ND	66	ND	65	ND	70	ND	64	ND	50	ND	67
4-Nitrophenol	ND	64	ND	67	ND	67	ND	66	ND	72	ND	65	ND	51	ND	68
Dibenzofuran	ND	230	ND	240	ND	240	ND	230	ND	250	ND	230	ND	180	ND	240

TABLE 11
Summary of TCL Validated Semivolatile Organic Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location Golder Sample ID Laboratory Sample ID Sample Depth (feet) Sample Type Sample Date	SITE 22A												SITE 36					
	COSO22A04		COSO22A07		COSO22A08		COSO22A13		COSO22A10		COSO22A11		COSE3601		COSE3604		COSL3603	
	93416		95206		95214		95249		95222		95230		103357		103438		100323	
	1.5 to 2.0		1.0 to 1.2		2.0 to 2.5		2.0 to 2.5		1.0 to 1.1		2.2 to 2.5		1.0 to 1.5		1.0 to 1.5		0.0 to 1.0	
	Investigative		Investigative		Investigative		Duplicate of COSO22A08		Investigative		Investigative		Investigative		Duplicate of COSE3601		Investigative	
04/29/93		05/03/93		05/03/93		05/03/93		05/03/93		05/03/93		06/09/93		06/09/93		05/05/93		
Compound	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg
2,4-Dinitrotoluene	ND	95	ND	99	ND	99	ND	97	ND	108	ND	98	ND	75	ND	75	ND	100
2,6-Dinitrotoluene	ND	115	ND	120	ND	120	ND	118	ND	128	ND	117	ND	91	ND	91	ND	121
Diethyl phthalate	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	120	ND	160
4-Chlorophenyl phenyl ether	ND	130	ND	130	ND	130	ND	130	ND	140	ND	130	ND	100	ND	100	ND	130
Fluorene	ND	102	ND	106	ND	106	ND	105	ND	114	ND	104	ND	81	ND	81	ND	108
4-Nitroaniline	ND	770	ND	800	ND	800	ND	790	ND	860	ND	780	ND	610	ND	610	ND	810
2-methyl-4,6-dinitrophenol	ND	230	ND	240	ND	240	ND	230	ND	250	ND	230	ND	180	ND	180	ND	240
n-Nitrosodiphenylamine	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	120	ND	160
4-Bromophenyl phenyl ether	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	120	ND	160
Hexachlorobenzene	ND	150	ND	160	ND	160	ND	160	ND	170	ND	150	ND	120	ND	120	ND	160
Pentachlorophenol	ND	1010	ND	1050	ND	1050	ND	1040	ND	1130	ND	1020	ND	800	ND	800	ND	1070
Phenanthrene	ND	130	ND	130	ND	130	ND	130	210	140	ND	130	ND	100	ND	100	ND	130
Anthracene	ND	130	ND	130	ND	130	ND	130	200	140	ND	130	ND	100	ND	100	ND	130
Di-n-butyl phthalate	ND	130	ND	130	ND	130	ND	130	ND	140	ND	130	ND	100	ND	100	ND	130
Fluoranthene	ND	115	260	120	ND	120	ND	118	560	128	ND	117	ND	91	120	91	ND	121
Pyrene	ND	230	240	240	ND	240	ND	230	590	250	ND	230	ND	180	ND	180	ND	240
Butyl benzyl phthalate	ND	230	ND	240	ND	240	ND	230	ND	250	ND	230	ND	180	ND	180	ND	240
3,3-Dichlorobenzidine	ND	230	ND	240	ND	240	ND	230	ND	250	ND	230	ND	180	ND	180	ND	240
Benzo(a)anthracene	ND	230	ND	240	ND	240	ND	230	550	250	ND	230	ND	180	ND	180	ND	240
bis(2-Ethylhexyl)phthalate	ND	380	ND	390	ND	390	ND	390	ND	420	ND	380	ND	300	ND	300	ND	400
Chrysene	ND	250	ND	260	ND	260	ND	260	630	280	ND	260	ND	200	ND	200	ND	270
Di-n-octyl phthalate	ND	200	ND	210	ND	210	ND	210	ND	220	ND	200	ND	160	ND	160	ND	210
Benzo(b)fluoranthene	ND	220	300	220	ND	220	ND	220	720	240	ND	220	ND	170	ND	170	ND	230
Benzo(k)fluoranthene	ND	420	ND	430	ND	430	ND	430	ND	460	ND	420	ND	330	ND	330	ND	440
Benzo(a)pyrene	ND	230	ND	240	ND	240	ND	230	390	250	ND	230	ND	180	ND	180	ND	240
Indeno(1,2,3-c,d)pyrene	ND	200	ND	210	ND	210	ND	210	ND	220	ND	200	ND	160	ND	160	ND	210
Dibenz(a,h)anthracene	ND	84	ND	87	ND	87	ND	86	ND	93	ND	85	ND	66	ND	66	ND	88
Benzo(g,h,i)perylene	ND	200	ND	210	ND	210	ND	210	ND	220	ND	200	ND	160	ND	160	ND	210

Notes:

ND -- Not detected at or above the MDL.

MDL -- Method Detection Limit

Conc. -- Concentration (dry-weight basis)

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard

SO -- Soil / SE -- Sediment / SL -- Sludge

22A -- Site Number

01 -- Sample Number

Created: SK

Reviewed: RP

Checked: MD

TABLE 11
Summary of Validated Semivolatile Organic Analyses for Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site	SITE 36							
Location								
Golden Sample ID	COSL3604		COSL3605		COSL3606		COSL3607	
Laboratory Sample ID	100331		100340		100299		100250	
Sample Depth (feet)	0.0 to 1.0		0.0 to 1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Investigative		Investigative	
Sample Date	05/05/93		05/05/93		05/04/93		05/04/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
INDIVIDUAL PARAMETERS								
Carbazole	ND	920	ND	800	ND	480	ND	500
n-Nitrosodimethylamine	ND	920	ND	800	ND	480	ND	500
SEMIVOLATILE ORGANICS								
Phenol	ND	189	ND	166	ND	96	ND	103
bis(2-Chloroethoxy)ether	ND	253	ND	222	ND	128	ND	138
2-Chlorophenol	ND	360	ND	320	ND	180	ND	200
1,3-Dichlorobenzene	ND	180	ND	158	ND	92	ND	98
1,4-Dichlorobenzene	ND	194	ND	171	ND	98	ND	106
1,2-Dichlorobenzene	ND	189	ND	166	ND	96	ND	103
2-Methylphenol	ND	330	ND	290	ND	170	ND	180
bis(2-Chloroisopropyl)ether	ND	253	ND	222	ND	128	ND	138
4-Methylphenol	ND	119	ND	105	ND	60	ND	65
n-Nitrosodi-n-propylamine	ND	222	ND	195	ND	113	ND	121
Hexachloroethane	ND	156	ND	136	ND	79	ND	85
Nitrobenzene	ND	300	ND	270	ND	150	ND	170
Isophorone	ND	330	ND	290	ND	170	ND	180
2-Nitrophenol	ND	640	ND	560	ND	320	ND	350
2,4-Dimethylphenol	ND	440	ND	390	ND	220	ND	240
bis(2-Chloroethoxy)methane	ND	420	ND	360	ND	210	ND	230
2,4-Dichlorophenol	ND	500	ND	440	ND	250	ND	270
1,2,4-Trichlorobenzene	ND	253	ND	222	ND	128	ND	138
Naphthalene	6100	253	5800	2220	ND	128	ND	138
4-Chloroaniline	ND	760	ND	660	ND	390	ND	420
Hexachlorobutadiene	ND	230	ND	202	ND	117	ND	126
4-Chloro-3-methylphenol	ND	440	ND	390	ND	220	ND	240
2-Methylnaphthalene	18900	5000	13600	4400	ND	250	ND	270
Hexachlorocyclopentadiene	ND	330	ND	290	ND	170	ND	180
2,4,6-Trichlorophenol	ND	420	ND	360	ND	210	ND	230
2,4,5-Trichlorophenol	ND	225	ND	198	ND	114	ND	123
2-Chloronaphthalene	ND	253	ND	222	ND	128	ND	138
2-Nitroaniline	ND	610	ND	540	ND	310	ND	330
Dimethyl phthalate	ND	180	ND	158	ND	92	ND	98
Acenaphthylene	ND	208	ND	183	ND	106	ND	114
3-Nitroaniline	ND	780	ND	680	ND	390	ND	420
Acenaphthene	28000	2250	18300	1980	ND	114	ND	123
2,4-Dinitrophenol	ND	139	ND	122	ND	70	ND	76
4-Nitrophenol	ND	142	ND	124	ND	72	ND	77
Dibenzofuran	19700	5000	13200	4400	ND	250	ND	270

Golden Associates

TABLE 11
Summary of Validated Semivolatile Organic Analyses for Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site	SITE 36							
Location								
Golden Sample ID	COSL3604		COSL3605		COSL3606		COSL3607	
Laboratory Sample ID	100331		100340		100289		100250	
Sample Depth (feet)	0.0 to 1.0		0.0 to 1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Investigative		Investigative	
Sample Date	05/05/93		05/05/93		05/04/93		05/04/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
2,4-Dinitrotoluene	ND	208	ND	183	ND	108	ND	114
2,6-Dinitrotoluene	ND	253	ND	222	ND	128	ND	138
Diethyl phthalate	ND	330	ND	290	ND	170	ND	180
4-Chlorophenyl phenyl ether	ND	280	ND	240	ND	140	ND	150
Fluorene	44000	2250	29000	1980	ND	114	ND	123
4-Nitroaniline	ND	1890	ND	1490	ND	860	ND	920
2-methyl-4,6-dinitrophenol	ND	500	ND	440	ND	250	ND	270
n-Nitrosodiphenylamine	ND	330	ND	290	ND	170	ND	180
4-Bromophenyl phenyl ether	ND	330	ND	290	ND	170	ND	180
Hexachlorobenzene	ND	330	ND	290	ND	170	ND	180
Pentachlorophenol	ND	2220	ND	1950	ND	1130	ND	1210
Phenanthrene	50000	2800	32000	2400	ND	140	ND	150
Anthracene	9400	280	6300	2400	ND	140	ND	150
Di-n-butyl phthalate	ND	280	ND	240	ND	140	ND	150
Fluoranthene	24200	2530	14400	2220	ND	128	ND	138
Pyrene	13900	5000	8000	4400	ND	250	ND	270
Butyl benzyl phthalate	ND	500	ND	440	ND	250	ND	270
3,3-Dichlorobenzidine	ND	500	ND	440	ND	250	ND	270
Benzo(a)anthracene	3900	500	2700	440	ND	250	ND	270
bis(2-Ethylhexyl)phthalate	1220	830	ND	730	ND	420	ND	450
Chrysene	2610	560	1490	490	ND	280	ND	300
Di-n-octyl phthalate	ND	440	ND	390	ND	220	ND	240
Benzo(b)fluoranthene	3900	470	1850	410	ND	240	ND	260
Benzo(k)fluoranthene	ND	920	ND	800	ND	460	ND	500
Benzo(a)pyrene	1440	500	900	440	ND	250	ND	270
Indeno(1,2,3-c,d)pyrene	ND	440	ND	390	ND	220	ND	240
Dibenz(a,h)anthracene	ND	183	ND	161	ND	93	ND	100
Benzo(g,h,i)perylene	ND	440	ND	390	ND	220	ND	240

Notes:

ND -- Not detected at or above the MDL.

MDL -- Method Detection Limit

Conc. -- Concentration (dry-weight basis)

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard

SO -- Soil / SE -- Sediment / SL -- Sludge

22A -- Site Number

01 -- Sample Number

Created: SK

Reviewed: RP

Checked: MD

TABLE 12
Summary of Validated TCL Organochlorine Pesticide and PCB Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 7		SITE 7A				SITE 8		SITE 9		SITE 10			
Golder Sample ID	COSE0701		COS007A01				COS00801		COSE0901		COSE1001			
Laboratory Sample ID	103608		103659				103454		103497		107840			
Sample Depth (feet)	1.7 to 1.8		1.4				1.6 to 1.7		2.0 to 2.1		1.5 to 1.8			
Sample Type	Investigative		Investigative				Investigative		Investigative		Investigative			
Sample Date	05/07/93		05/07/93				05/07/93		05/06/93		05/06/93			
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
ORGANOCHLORINE PESTICIDES AND PCBs														
Aldrin	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
a - BHC	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
b - BHC	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
g - BHC (Lindane)	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
d - BHC	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
Chlordane (tech)	ND	83	ND	83	ND	81	ND	84	ND	84	ND	83	ND	89
4,4' - DDD	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
4,4' - DDE	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
4,4' - DDT	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
Dieldrin	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
Endosulfan I	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
Endosulfan II	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
Endosulfan Sulfate	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
Endrin	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
Endrin aldehyde	ND	4.1	ND	4.1	ND	4.0	ND	4.1	ND	4.1	ND	4.1	ND	4.4
Heptachlor	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
Heptachlor epoxide	ND	2.1	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.3
Methoxychlor	ND	21	ND	21	ND	20	ND	21	ND	21	ND	21	ND	23
Toxaphene	ND	210	ND	210	ND	200	ND	210	ND	210	ND	210	ND	230
PCB - 1016	ND	41	ND	41	ND	40	ND	41	ND	41	ND	41	ND	44
PCB - 1221	ND	83	ND	83	ND	81	ND	84	ND	84	ND	83	ND	89
PCB - 1232	ND	41	ND	41	ND	40	ND	41	ND	41	ND	41	ND	44
PCB - 1242	ND	41	ND	41	ND	40	ND	41	ND	41	ND	41	ND	44
PCB - 1248	ND	41	ND	41	ND	40	ND	41	ND	41	ND	41	ND	44
PCB - 1254	ND	41	ND	41	ND	40	ND	41	ND	41	ND	41	ND	44
PCB - 1280	ND	41	ND	41	ND	40	ND	41	ND	41	ND	41	ND	44

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COS022A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 12
Summary of Validated TCL Organochlorine Pesticide and PCB Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 11		SITE 11A						SITE 12					
Golden Sample ID	COSO1101		COSO11A01		COSO11A09		COSO11A02		COSO11A03		COSO11A04		COSO1201	
Laboratory Sample ID	103632		107875		108138		107883		107930		107948		93807	
Sample Depth (feet)	1.7 to 1.9		1.5 to 1.6		1.5 to 1.6		1.7 to 1.9		1.7 to 1.8		1.7 to 1.8		1.8 to 2.2	
Sample Type	Investigative		Investigative		Duplicate of COS11A01		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/10/93		05/10/93		05/10/93		05/10/93		05/10/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
ORGANOCHLORINE PESTICIDES AND PCBs														
Aldrin	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
a - BHC	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
b - BHC	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
g - BHC (Lindane)	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
d - BHC	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
Chlordane (tech)	ND	85	ND	82	ND	80	ND	84	ND	84	ND	102	ND	83
4,4' - DDD	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
4,4'-DDE	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
4,4' - DDT	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
Dieldrin	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
Endosulfan I	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
Endosulfan II	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
Endosulfan Sulfate	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
Endrin	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
Endrin aldehyde	ND	4.2	ND	4.0	ND	3.9	ND	4.1	ND	4.1	ND	5.0	ND	4.1
Heptachlor	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
Heptachlor epoxide	ND	2.2	ND	2.1	ND	2.0	ND	2.1	ND	2.1	ND	2.6	ND	2.1
Methoxychlor	ND	22	ND	21	ND	20	ND	21	ND	21	ND	26	ND	21
Toxaphene	ND	220	ND	210	ND	200	ND	210	ND	210	ND	260	ND	210
PCB - 1016	ND	42	ND	40	ND	39	ND	41	ND	41	ND	50	ND	41
PCB - 1221	ND	85	ND	82	ND	80	ND	84	ND	84	ND	102	ND	83
PCB - 1232	ND	42	ND	40	ND	39	ND	41	ND	41	ND	50	ND	41
PCB - 1242	ND	42	ND	40	ND	39	ND	41	ND	41	ND	50	ND	41
PCB - 1248	ND	42	ND	40	ND	39	ND	41	ND	41	ND	50	ND	41
PCB - 1254	ND	42	ND	40	ND	39	ND	41	ND	41	ND	50	ND	41
PCB - 1260	ND	42	ND	40	ND	39	ND	41	ND	41	ND	50	ND	41

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 12
Summary of Validated TCL Organochlorine Pesticide and PCB Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 14				SITE 16				SITE 20				SITE 22A			
Golder Sample ID	COSO1401		COSO1403		COSO1601		COSO1603		COSO2001		COSO2002		COSO22A01		COSO22A02	
Laboratory Sample ID	100358		100374		100277		100283		90492		90506		93789		93777	
Sample Depth (feet)	1.4 to 1.5		1.4 to 1.5		0.5 to 0.6		0.7 to 0.8		1.0 to 2.0		1.0 to 2.0		0.8 to 1.0		2.4 to 2.7	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Duplicate of COSO2002		Investigative		Investigative	
Sample Date	05/03/93		05/05/93		05/04/93		05/04/93		04/28/93		04/28/93		04/30/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
ORGANOCHLORINE PESTICIDES AND PCBs																
Aldrin	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
a - BHC	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
b - BHC	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
g - BHC (Lindane)	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
d - BHC	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
Chlordane (tech)	ND	96	ND	93	ND	76	ND	90	ND	86	ND	86	ND	82	ND	84
4,4' - DDD	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	4.0	4.0	ND	4.1
															12.1 J (a)	4.1
4,4'-DDE	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	27	4.0	6.0	4.1
4,4' - DDT	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	23	4.0	6.9	4.1
Dieldrin	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	ND	4.0	ND	4.1
Endosulfan I	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
Endosulfan II	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	ND	4.0	ND	4.1
Endosulfan Sulfate	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	ND	4.0	ND	4.1
Endrin	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	ND	4.0	ND	4.1
Endrin aldehyde	ND	4.7	ND	4.6	ND	3.8	ND	4.4	ND	4.2	ND	4.2	ND	4.0	ND	4.1
Heptachlor	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
Heptachlor epoxide	ND	2.4	ND	2.4	ND	1.9	ND	2.3	ND	2.2	ND	2.2	ND	2.1	ND	2.1
Methoxychlor	ND	24	ND	24	ND	19	ND	23	ND	22	ND	22	ND	21	ND	21
Toxaphene	ND	240	ND	240	ND	190	ND	230	ND	220	ND	220	ND	210	ND	210
PCB - 1016	ND	47	ND	46	ND	38	ND	44	ND	42	ND	42	ND	40	ND	41
PCB - 1221	ND	96	ND	93	ND	76	ND	90	ND	86	ND	86	ND	82	ND	84
PCB - 1232	ND	47	ND	46	ND	38	ND	44	ND	42	ND	42	ND	40	ND	41
PCB - 1242	ND	47	ND	46	ND	38	ND	44	ND	42	ND	42	ND	40	ND	41
PCB - 1248	ND	47	ND	46	ND	38	ND	44	ND	42	ND	42	ND	40	ND	41
PCB - 1254	ND	47	ND	46	ND	38	103	44	ND	42	ND	42	ND	40	ND	41
PCB - 1260	ND	47	ND	46	ND	38	61	44	ND	42	ND	42	ND	40	ND	41

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 12
Summary of Validated TCL Organochlorine Pesticide and PCB Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Manon, Illinois

Site Location	SITE 22A						SITE 36					
Golden Sample ID	COSO22A04	COSO22A07	COSO22A08	COSO22A13	COSO22A10	COSO22A11	COSE3601	COSE3609	COSL3603			
Laboratory Sample ID	93416	95206	95214	95249	95222	95230	103357	103438	100323			
Sample Depth (feet)	1.5 to 2.0	1.0 to 1.2	2.0 to 2.5	2.0 to 2.5	1.0 to 1.1	2.2 to 2.5	1.0 to 1.5	1.0 to 1.5	0.0 to 1.0			
Sample Type	Investigative	Investigative	Investigative	Duplicate of COSO22A08	Investigative	Investigative	Investigative	Duplicate of COSE3601	Investigative			
Sample Date	04/28/93	05/03/93	05/03/93	05/03/93	05/03/93	05/03/93	05/06/93	05/06/93	05/05/93			
Compound	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg
ORGANOCHLORINE PESTICIDES AND PCBs												
Aldrin	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.2	ND	2.2	770 J (a)	3000
a - BHC	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.2	ND	2.2	ND	3.0
b - BHC	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.2	ND	2.2	ND	3.0
g - BHC (Lindane)	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.2	ND	2.2	ND	3.0
d - BHC	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.2	ND	2.2	ND	3.0
Chlordane (tech)	ND	85	ND	88	ND J (b)	88	ND	94	ND	86	ND	118
4,4' - DDD	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
4,4' - DDE	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
4,4' - DDT	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
Dieldrin	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
Endosulfan I	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.4	ND	2.2	ND	3.0
Endosulfan II	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
Endosulfan Sulfate	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
Endrin	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
Endrin aldehyde	ND	4.2	ND	4.3	ND J (b)	4.3	ND	4.6	ND	4.2	ND	5.8
Heptachlor	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.4	ND	2.2	ND	3.0
Heptachlor epoxide	ND	2.2	ND	2.2	ND J (b)	2.2	ND	2.4	ND	2.2	ND	3.0
Methoxychlor	ND	22	ND	22	ND J (b)	22	ND	24	ND	22	ND	30
Toxaphene	ND	220	ND	220	ND J (b)	220	ND	240	ND	220	ND	300
PCB - 1016	ND	42	ND	43	ND J (b)	43	ND	46	ND	42	ND	58
PCB - 1221	ND	85	ND	88	ND J (b)	88	ND	94	ND	86	ND	118
PCB - 1232	ND	42	ND	43	ND J (b)	43	ND	46	ND	42	ND	58
PCB - 1242	ND	42	ND	43	ND J (b)	43	ND	46	ND	42	ND	58
PCB - 1248	ND	42	ND	43	ND J (b)	43	ND	46	ND	42	8900 J (a)	5800
PCB - 1254	ND	42	ND	43	ND J (b)	43	ND	46	ND	42	8200 J (a)	5800
PCB - 1260	ND	42	ND	43	ND J (b)	43	ND	46	ND	42	950 J (a)	58

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 12
Summary of Validated TCL Organochlorine Pesticide and PCB Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 36							
Golder Sample ID	COSL3604		COSL3605		COSL3606		COSL3607	
Laboratory Sample ID	100331		100340		100289		100250	
Sample Depth (feet)	0.0 to 1.0		0.0 to 1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Investigative		Investigative	
Sample Date	05/05/93		05/05/93		05/04/93		05/04/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
ORGANOCHLORINE PESTICIDES AND PCBs								
Aldrin	3300 J (c)	4700	1580 J (c)	4100	ND	2.4	ND	2.6
a - BHC	ND	4.7	ND	4.1	ND	2.4	ND	2.6
b - BHC	ND	4.7	ND	4.1	ND	2.4	ND	2.6
g - BHC (Lindane)	ND	4.7	ND	4.1	ND	2.4	ND	2.6
d - BHC	ND	4.7	ND	4.1	ND	2.4	ND	2.6
Chlordane (tech)	ND	186	ND	163	ND	94	ND	102
4,4' - DDD	ND	9.2	ND	8.0	ND	4.6	ND	5.0
4,4' - DDE	ND	9.2	ND	8.0	ND	4.6	ND	5.0
4,4' - DDT	ND	9.2	ND	8.0	ND	4.6	ND	5.0
Dieldrin	ND	9.2	ND	8.0	ND	4.6	ND	5.0
Endosulfan I	ND	4.7	ND	4.1	ND	2.4	ND	2.6
Endosulfan II	ND	9.2	ND	8.0	ND	4.6	ND	5.0
Endosulfan Sulfate	ND	9.2	ND	8.0	ND	4.6	ND	5.0
Endrin	ND	9.2	ND	8.0	ND	4.6	ND	5.0
Endrin aldehyde	ND	9.2	ND	8.0	ND	4.6	ND	5.0
Heptachlor	ND	4.7	ND	4.1	ND	2.4	ND	2.6
Heptachlor epoxide	ND	4.7	ND	4.1	ND	2.4	ND	2.6
Methoxychlor	ND	47	ND	41	ND	24	ND	26
Toxaphene	ND	470	ND	410	ND	240	ND	260
PCB - 1016	ND	92	ND	80	ND	46	ND	50
PCB - 1221	ND	186	ND	163	ND	94	ND	102
PCB - 1232	ND	92	ND	80	ND	46	ND	50
PCB - 1242	ND	92	ND	80	ND	46	ND	50
PCB - 1248	42000 J (c)	9200	20700 J (c)	8000	59	46	150	50
PCB - 1254	80000 J (c)	9200	34000 J (c)	8000	59	46	180	50
PCB - 1260	7800 J (c)	9200	4100 J (c)	8000	ND	46	ND	50

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

Created: SK
Reviewed: RP
Checked: MD

TABLE 13
Summary of Validated Explosive Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 7		SITE 7A				SITE 8		SITE 9		SITE 10			
Golden Sample ID	COSE0701		COSO07A01		COSO07A03		COSO07A05		COSO07A07		COSO0801		COSE1001	
Laboratory Sample ID	103608		103659		103675		103691		103713		103454		103497	
Sample Depth (feet)	1.7 to 1.8		1.4		1.5 to 1.6		1.6 to 1.7		1.5		1.6 to 1.7		2.0 to 2.1	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/07/93		05/07/93		05/07/93		05/07/93		05/08/93		05/08/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
EXPLOSIVES														
HMX	ND	616	ND	616	ND	601	ND	624	ND	624	ND	616	ND	703
RDX	ND	630	ND	630	ND	610	ND	640	ND	640	ND	630	ND	720
1,3,5-Trinitrobenzene	ND	310	ND	310	ND	300	ND	310	ND	310	ND	310	ND	350
1,3-Dinitrobenzene	ND	307	ND	307	ND	300	ND	311	ND	311	ND	307	ND	351
Tetryl	ND	1570	ND	1570	ND	1530	ND	1590	ND	1590	ND	1570	ND	1790
Nitroglycerin	ND	3100	ND	3100	ND	3000	ND	3100	ND	3100	ND	3100	ND	3500
2,4,6-Trinitrotoluene	ND	310	ND	310	ND	300	ND	310	ND	310	ND	310	ND	350
2,6-Dinitrotoluene	ND	600	ND	600	ND	600	ND	600	ND	600	ND	600	ND	700
2,4-Dinitrotoluene	ND	310	ND	310	ND	302	ND	314	ND	314	ND	310	ND	354
2-Nitrotoluene	ND	620	ND	620	ND	610	ND	630	ND	630	ND	620	ND	710
4-Nitrotoluene	ND	302	ND	302	ND	295	ND	306	ND	306	ND	302	ND	345
3-Nitrotoluene	ND	310	ND	310	ND	302	ND	314	ND	314	ND	310	ND	354
PETN	ND	3100	ND	3100	ND	3000	ND	3100	ND	3100	ND	3100	ND	3500

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J --- The associated value is an estimated quantity
a --- Concentration qualified due to poor MS/MSD recoveries
d --- Result is biased negatively

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 13

Summary of Validated Explosive Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 11		SITE 11A						SITE 12					
Golder Sample ID	COSO1101		COSO11A01		COSO11A09		COSO11A02		COSO11A03		COSO11A04		COSO1201	
Laboratory Sample ID	103632		107875		108138		107883		107930		107948		93807	
Sample Depth (feet)	1.7 to 1.9		1.5 to 1.6		1.5 to 1.6		1.7 to 1.9		1.7 to 1.8		1.7 to 1.8		1.8 to 2.2	
Sample Type	Investigative		Investigative		Duplicate of COS11A01		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/10/93		05/10/93		05/10/93		05/10/93		05/10/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
EXPLOSIVES														
HMX	ND	632	ND	608	ND	564	ND	624	ND	624	ND	756	ND	616
RDX	ND	640	ND	620	ND	610	ND	640	ND	640	ND	770	ND	630
1,3,5-Trinitrobenzene	ND	320	ND	300	ND	300	ND	310	ND	310	ND	380	ND	310
1,3-Dinitrobenzene	ND	315	ND	304	ND	296	ND	311	ND	311	ND	377	ND	307
Tetryl	ND	1610	ND	1550	ND	1510	ND	1590	ND	1590	ND	1920	ND	1570
Nitroglycerin	ND	3200	ND	3000	ND	3000	ND	3100	ND	3100	ND	3800	ND	3100
2,4,6-Trinitrotoluene	ND	320	ND	300	ND	300	ND	310	380	310	ND	380	ND	310
2,6-Dinitrotoluene	ND	600	ND	600	ND	600	ND	600	ND	600	ND	800	ND	600
2,4-Dinitrotoluene	ND	318	ND	306	ND	299	ND	314	ND	314	ND	380	ND	310
2-Nitrotoluene	ND	640	ND	620	ND	600	ND	630	ND	630	ND	760	ND	620
4-Nitrotoluene	ND	310	ND	299	ND	292	ND	306	ND	306	ND	371	ND	302
3-Nitrotoluene	ND	318	ND	306	ND	299	ND	314	ND	314	ND	380	ND	310
PETN	ND	3200	ND	3000	ND	3000	ND	3100	ND	3100	ND	3800	ND	3100

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity
a -- Concentration qualified due to poor MS/MSD recoveries
d -- Result is biased negatively

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 13
Summary of Validated Explosive Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 14				SITE 16				SITE 20				SITE 22A			
Golder Sample ID	COSO1401		COSO1403		COSO1601		COSO1603		COSO2001		COSO2002		COSO22A01		COSO22A02	
Laboratory Sample ID	100358		100374		100277		100293		90492		90506		93769		93777	
Sample Depth (feet)	1.4 to 1.5		1.4 to 1.5		0.5 to 0.6		0.7 to 0.8		1.0 to 2.0		1.0 to 2.0		0.8 to 1.0		2.4 to 2.7	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Duplicate of COSO2002		Investigative		Investigative	
Sample Date	05/03/93		05/05/93		05/04/93		05/04/93		04/28/93		04/28/93		04/30/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
EXPLOSIVES																
HMX	ND	713	ND	693	ND	567	ND	674	ND	640	ND	640	ND	606	ND	624
RDX	ND	730	ND	710	ND	580	ND	690	ND	650	ND	650	ND	620	ND	640
1,3,5-Trinitrobenzene	ND	360	ND	350	ND	280	ND	340	ND	320	ND	320	ND	300	ND	310
1,3-Dinitrobenzene	ND	356	ND	346	ND	283	ND	336	ND	319	ND	319	ND	304	ND	311
Tetryl	ND	1810	ND	1760	ND	1440	ND	1720	ND	1630	ND	1630	ND	1550	ND	1590
Nitroglycerin	ND	3600	ND	3500	ND	2800	ND	3400	ND	3200	ND	3200	ND	3000	ND	3100
2,4,6-Trinitrotoluene	ND	360	ND	350	ND	280	ND	340	ND	320	ND	320	ND	300	ND	310
2,6-Dinitrotoluene	ND	700	ND	700	ND	600	ND	700	ND	600	ND	600	ND	600	ND	600
2,4-Dinitrotoluene	ND	358	ND	349	ND	285	ND	339	ND	322	ND	322	ND	306	ND	314
2-Nitrotoluene	ND	720	ND	700	ND	570	ND	680	ND	650	ND	650	ND	620	ND	630
4-Nitrotoluene	ND	350	ND	340	ND	278	ND	331	ND	314	ND	314	ND	299	ND	306
3-Nitrotoluene	ND	358	ND	349	ND	285	ND	339	ND	322	ND	322	ND	306	ND	314
PETN	ND	3600	ND	3500	ND	2800	ND	3400	ND	3200	ND	3200	ND	3000	ND	3100

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J --- The associated value is an estimated quantity
a --- Concentration qualified due to poor MS/MSD recoveries
d --- Result is biased negatively

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 13
Summary of Validated Explosive Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 22A						SITE 36					
Golden Sample ID	COSO22A04	COSO22A07	COSO22A08	COSO22A13	COSO22A10	COSO22A11	COSE3601	COSE3609	COSE3603			
Laboratory Sample ID	93416	95206	95214	95249	95222	95230	103357	103438	100323			
Sample Depth (feet)	1.5 to 2.0	1.0 to 1.2	2.0 to 2.5	2.0 to 2.5	1.0 to 1.1	2.2 to 2.5	1.0 to 1.5	1.0 to 1.5	0.0 to 1.0			
Sample Type	Investigative	Investigative	Investigative	Duplicate of COSO22A0	Investigative	Investigative	Investigative	Duplicate of COSE3601	Investigative			
Sample Date	04/29/93	05/03/93	05/03/93	05/03/93	05/03/93	05/03/93	05/06/93	05/06/93	05/05/93			
Compound	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg	Conc. ug/Kg	MDL ug/Kg
EXPLOSIVES												
HMX	ND	632	ND	656	ND	656	ND	703	ND	640	ND	675
RDX	ND	640	ND	670	ND	670	ND	660	ND	650	ND	690
1,3,5-Trinitrobenzene	ND	320	ND	330	ND	330	ND	320	ND	350	ND	440
1,3-Dinitrobenzene	ND	315	ND	328	ND	328	ND	323	ND	361	ND	437
Tetryl	ND	1610	ND	1670	ND	1670	ND	1650	ND	1790	ND	2230
Nitroglycerin	ND	3200	ND	3300	ND	3300	ND	3200	ND	3500	ND	4400
2,4,6-Trinitrotoluene	ND	320	ND	330	ND	330	ND	320	ND	350	ND	440
2,6-Dinitrotoluene	ND	600	ND	600	ND	600	ND	700	ND	600	ND	900
2,4-Dinitrotoluene	ND	318	ND	330	ND	330	ND	326	ND	354	ND	440
2-Nitrotoluene	ND	640	ND	660	ND	660	ND	710	ND	650	ND	880
4-Nitrotoluene	ND	310	ND	322	ND	322	ND	318	ND	345	ND	430
3-Nitrotoluene	ND	318	ND	330	ND	330	ND	326	ND	354	ND	440
PETN	ND	3200	ND	3300	ND	3300	ND	3200	ND	3500	ND	4400

Notes:

ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
J -- The associated value is an estimated quantity
a -- Concentration qualified due to poor MS/MSD recoveries
d -- Result is biased negatively

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 13
Summary of Validated Explosive Compound Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 36							
Golder Sample ID	COSL3604		COSL3605		COSL3606		COSL3607	
Laboratory Sample ID	100331		100340		100269		100250	
Sample Depth (feet)	0.0 to 1.0		0.0 to 1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Investigative		Investigative	
Sample Date	05/05/93		05/05/93		05/04/93		05/04/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
EXPLOSIVES								
HMX	ND	1386	ND	1217	ND	703	ND	756
RDX	ND	1420	ND	1240	ND	720	ND	770
1,3,5-Trinitrobenzene	ND	690	ND J e	610	ND	350	ND	380
1,3-Dinitrobenzene	ND	692	ND J e	607	ND	351	ND	377
Tetryl	ND	3530	ND J e	3100	ND	1790	ND	1920
Nitroglycerin	ND	6900	ND J e	6100	ND	3500	ND	3800
2,4,6-Trinitrotoluene	ND	690	ND	610	ND	350	ND	380
2,6-Dinitrotoluene	ND	1400	ND	1200	ND	700	ND	800
2,4-Dinitrotoluene	ND	697	ND J d	612	ND	354	ND	380
2-Nitrotoluene	ND	1400	ND	1230	ND	710	ND	780
4-Nitrotoluene	ND	680	ND	598	ND	345	ND	371
3-Nitrotoluene	ND	697	ND	612	ND	354	ND	380
PETN	ND	6900	ND J e	6100	ND	3500	ND	3800

Notes:

ND -- Not detected at or above the MDL.

MDL -- Method Detection Limit

Conc. -- Concentration (dry-weight basis)

J --- The associated value is an estimated quantity

a --- Concentration qualified due to poor MS/MSD recoveries

d --- Result is biased negatively

e --- Biased low due to MS/MSD recovery.

Sample ID Breakdown (COSO22A01):

CO -- Crab Orchard

SO -- Soil / SE-- Sediment / SL-- Sludge

22A -- Site Number

01 -- Sample Number

Created: SK

Reviewed: RP

Checked: MD

TABLE 14
Summary of Validated Dioxins/Furans Analyses of Soil Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 22A											
Golder Sample ID	COSO22A01	COSO22A02	COSO22A03	COSO22A03	COSO22A04	COSO22A07						
Laboratory Sample ID	9376.9	9377.7	9342.4	9342.4 DIL	9341.6	9520.6						
Sample Depth (feet)	0.8 to 1.0	2.4 to 2.7	0.6 to 0.8	0.6 to 0.8	1.5 to 2.0	1.0 to 1.2						
Sample Type	Investigative	Investigative	Investigative	Investigative	Investigative	Investigative						
Sample Date	04/30/93	04/30/93	04/29/93	04/29/93	04/29/93	05/03/93						
Compound	Conc. ug/Kg	DL ug/Kg	Conc. ug/Kg	DL ug/Kg	Conc. ug/Kg	DL ug/Kg	Conc. ug/Kg	DL ug/Kg	Conc. ug/Kg	DL ug/Kg	Conc. ug/Kg	DL ug/Kg
2,3,7,8-TCDD	ND	0.076	ND	0.08	ND	0.073	ND	0.073	ND	0.073	ND	0.072
1,2,3,7,8-PeCDD	ND	0.13	ND	0.14	ND	0.13	ND	0.13	ND	0.13	ND	0.13
1,2,3,4,7,8-HxCDD	ND	0.22	ND	0.23	0.469	0.21	ND	0.21	ND	0.21	ND	0.21
1,2,3,6,7,8-HxCDD	ND	0.11	ND	0.11	1.73	0.11	0.413	0.11	ND	0.11	ND	0.1
1,2,3,7,8,9-HxCDD	ND	0.18	ND	0.19	ND	0.18	ND	0.18	ND	0.18	ND	0.18
1,2,3,4,6,7,8-HpCDD	0.434	0.22	ND	0.23	63	0.21	23.8	0.21	2.88	0.21	9.52	0.21
OCDD	9.01	0.29	7.63	0.31	600	0.28	164	0.28	31.8	0.28	103	0.28
2,3,7,8-TCDF	ND	0.066	ND	0.07	ND	0.064	ND	0.064	ND	0.064	ND	0.063
1,2,3,7,8-PeCDF	ND	0.1	ND	0.11	ND	0.1	ND	0.1	ND	0.1	ND	0.099
2,3,4,7,8-PeCDF	ND	0.11	ND	0.11	ND	0.1	0.114	0.1	ND	0.1	ND	0.1
1,2,3,4,7,8-HxCDF	ND	0.12	ND	0.13	0.376	0.12	ND	0.12	ND	0.12	ND	0.12
1,2,3,6,7,8-HxCDF	ND	0.095	ND	0.1	5.22	0.091	1.48	0.091	ND	0.092	0.518	0.09
2,3,4,6,7,8-HxCDF	ND	0.18	ND	0.18	0.228	0.17	ND	0.17	ND	0.17	ND	0.17
1,2,3,7,8,9-HxCDF	ND	0.23	ND	0.24	ND	0.22	ND	0.22	ND	0.22	ND	0.22
1,2,3,4,6,7,8-HpCDF	ND	0.18	ND	0.19	17	0.17	ND	0.17	0.836	0.17	1.85	0.17
1,2,3,4,7,8,9-HpCDF	ND	0.19	ND	0.2	1.04	0.19	ND	0.19	ND	0.19	ND	0.18
OCDF	ND	0.36	ND	0.38	89.3	0.35	23.3	0.35	5.79	0.35	8.39	0.34

Notes:

ND -- Not detected at or above the DL.

DL -- Detection Limit

Conc. -- Concentration (dry-weight basis)

CDD -- Chlorinated dibenzo-p-dioxins

CDF -- Chlorinated dibenzofurans

J -- The associated value is an estimated quantity.

U -- The associated result is estimated as non-detect.

(a) -- Biased high due to surrogate recovery.

(b) -- Biased low due to surrogate recovery.

(c) -- Estimated due to surrogate recovery related to sample dilution.

(d) -- Biased high due to MS/MSD recovery.

(e) -- Biased low due to MS/MSD recovery.

(f) -- Biased high due to LCS recovery.

(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

CO CO -- Crab Orchard

SO SO -- Soil Sample

22A 22A -- Site Number

01 01 -- Sample Number

TABLE 14
Summary of Validated Dioxins/Furans Analyses of Soil Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site	SITE 22A									
Location										
Golden Sample ID										
Laboratory Sample ID										
Sample Depth (feet)										
Sample Type										
Sample Date										
Compound	Conc.	DL	Conc.	DL	Conc.	DL	Conc.	DL	Conc.	DL
	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
2,3,7,8-TCDD	ND	0.063	ND	0.068	ND	0.051	ND	0.051	ND	0.081
1,2,3,7,8-PeCDD	ND	0.11	ND	0.12	ND	0.09	ND	0.09	ND	0.14
1,2,3,4,7,8-HxCDD	ND	0.18	ND	0.19	ND	0.15	ND	0.15	ND	0.23
1,2,3,6,7,8-HxCDD	ND	0.09	ND	0.097	0.464	0.074	0.177	0.074	0.197	0.12
1,2,3,7,8,9-HxCDD	ND	0.15	ND	0.16	0.24	0.12	ND	0.12	ND	0.2
1,2,3,4,6,7,8-HpCDD	3.65	0.18	3.65	0.2	12.7	0.15	7.43	0.15	7.66	0.23
OCDD	45.5	0.24	39.8	0.26	91	0.2	47.4	0.2	69.8	0.31
2,3,7,8-TCDF	ND	0.055	ND	0.059	ND	0.045	ND	0.045	ND	0.07
1,2,3,7,8-PeCDF	ND	0.085	ND	0.092	ND	0.07	ND	0.07	ND	0.11
2,3,4,7,8-PeCDF	ND	0.089	ND	0.096	ND	0.073	ND	0.073	ND	0.11
1,2,3,4,7,8-HxCDF	ND	0.1	ND	0.11	ND	0.082	ND	0.082	ND	0.13
1,2,3,6,7,8-HxCDF	ND	0.078	ND	0.084	0.751	0.064	0.456	0.064	0.318	0.1
2,3,4,6,7,8-HxCDF	ND	0.14	ND	0.16	ND	0.12	ND	0.12	ND	0.19
1,2,3,7,8,9-HxCDF	ND	0.19	ND	0.2	ND	0.15	ND	0.15	ND	0.24
1,2,3,4,6,7,8-HpCDF	0.729	0.15	0.694	0.16	ND	0.12	ND	0.12	1.45	0.19
1,2,3,4,7,8,9-HpCDF	ND	0.16	ND	0.17	ND	0.13	ND	0.13	ND	0.21
OCDF	3.45	0.3	3.31	0.32	8.12	0.24	3.64	0.24	4.74	0.38

Notes:

ND -- Not detected at or above the DL.

DL -- Detection Limit

Conc. -- Concentration (dry-weight basis)

CDD -- Chlorinated dibenzo-p-dioxins

CDF -- Chlorinated dibenzofurans

J -- The associated value is an estimated quantity.

U -- The associated result is estimated as non-detect.

(a) -- Biased high due to surrogate recovery.

(b) -- Biased low due to surrogate recovery.

(c) -- Estimated due to surrogate recovery related to sample dilution.

(d) -- Biased high due to MS/MSD recovery.

(e) -- Biased low due to MS/MSD recovery.

(f) -- Biased high due to LCS recovery.

(g) -- Biased low due to LCS recovery

Sample ID Breakdown (COSO22A01):

CO CO -- Crab Orchard

SO SO -- Soil / SE-- Sediment / SL-- Sludge

22A 22A -- Site Number

01 01 -- Sample Number

Created: SK

Reviewed: RP

Checked: MD

TABLE 15
Summary of Validated TAL Inorganic Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 7		SITE 7A						SITE 8		SITE 9		SITE 10			
Golden Sample ID	COSE0701		COSO07A01		COSO07A03		COSO07A05		COSO07A07		COSO0801		COSE0901		COSE1001	
Laboratory Sample ID	103608		103659		103675		103691		103713		103454		103497		107840	
Sample Depth (feet)	1.7 to 1.8		1.4		1.5 to 1.6		1.6 to 1.7		1.5		1.6 to 1.7		2.0 to 2.1		1.5 to 1.8	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative		Investigative	
Sample Date	05/07/93		05/07/93		05/07/93		05/07/93		05/07/93		05/08/93		05/08/93		05/08/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Arsenic	4.4	0.5	3.2	0.5	2.9 J (d)	0.4	4.9	0.4	3.4	0.4	2.5	0.5	4.9	0.5	4.6	0.5
Cyanide (Total)	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	1	ND	1	ND	0.7
Lead	11.4	0.2	7.6	0.2	7.2	0.8	11.4	0.9	7.9	0.9	12	0.2	15	0.2	12.8	0.3
Mercury	ND	0.02	0.04	0.02	0.02	0.02	0.04	0.02	ND	0.02	ND	0.02	ND	0.02	ND	0.03
Moisture Content (Percent)	19	0.1	19	0.1	17	0.1	20	0.1	20	0.1	20	0.1	19	0.1	29	0.1
Selenium	ND	1.5	ND	1.5	ND J (e)	1.4	ND	1.5	ND	1.5	ND	2.0	ND	2.0	ND	1.7
Thallium	0.33	0.2	0.36	0.2	ND	1	ND	1.0	ND	1.0	0.4	0.2	0.51	0.2	0.30	0.3
TARGET ANALYTE LIST																
Aluminum	9100	3.7	6000	3.7	6100	3.6	7100	3.8	9200	3.8	8400	3.8	7800	3.7	5100	4.2
Barium	120	0.6	51	0.6	130	0.6	62	0.6	60	0.6	150	0.6	150	0.6	68	0.7
Beryllium	0.92	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	0.86	0.6	0.89	0.6	ND	0.7
Cadmium	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	0.76	0.7
Calcium	16000	4.9	1180	4.9	13000	4.8	1090	5.0	1400	5.0	2800	5.0	2000	4.9	1500	5.6
Chromium	11.5	0.6	8.1	0.6	7.5	0.6	8.2	0.6	11.6	0.6	12	0.6	15	0.6	9.7	0.7
Cobalt	15	1	3.4	1	ND	1	ND	1	ND	1	8.5	1	16	1	8.4	1
Copper	12.2	0.6	5.2	0.6	5.7	0.6	6.1	0.6	9.2	0.6	10.6	0.6	14	0.6	8.9	0.7
Iron	16000	2.5	7800	2.5	8700	2.4	8000	2.5	11800	2.5	10500	2.5	22000	2.5	12800	2.8
Magnesium	9500	3.7	1010	3.7	1400	3.6	1000	3.8	1500	3.8	1800	3.8	1800	3.7	800	4.2
Manganese	1040	0.6	410	0.6	1200	0.6	310	0.6	280	0.6	250	0.6	900	0.6	560	0.7
Nickel	11.8	1.8	3.6	1.8	5.8	1.8	3.8	1.9	6.6	1.9	11.5	1.9	16	1.8	7.7	2.1
Potassium	347	62	310	62	190	60	240	62	350	62	310	62	470	62	390	70
Antimony	ND J (eg)	4.9	ND J (eg)	4.9	ND J (eg)	4.8	ND J (eg)	5.0	ND J (eg)	5.0	ND	5.0	ND	4.9	ND J (eg)	5.6
Silver	0.6	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	0.74	0.6	1.7	0.6	1.24	0.7
Sodium	370	1.8	60	1.8	120	1.8	150	1.9	120	1.9	310	1.9	180	1.8	65	2.1
Vanadium	26	0.6	16	0.6	18	0.6	15	0.6	21	0.6	22	0.6	23	0.6	22	0.7
Zinc	31	1	21	1	20	1	21	1	28	1	32	1	44	1	34	1

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
EQ -- Elevated quantitation limits resulting from matrix interference.
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE -- Sediment / SL -- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 15
Summary of Validated TAL Inorganic Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 11		SITE 11A								SITE 12					
Goldier Sample ID	COSO1101		COSO11A01		COSO11A09		COSO11A02		COSO11A03		COSO11A04		COSO1201		COSO1207	
Laboratory Sample ID	103632		107875		108138		107883		107930		107948		93807		93840	
Sample Depth (feet)	1.7 to 1.9		1.5 to 1.6		1.5 to 1.6		1.7 to 1.9		1.7 to 1.8		1.7 to 1.8		1.8 to 2.2		1.8 to 2.2	
Sample Type	Investigative		Investigative		Duplicate of COS11A01		Investigative		Investigative		Investigative		Investigative		Duplicate of COSO1201	
Sample Date	05/07/93		05/10/93		05/10/93		05/10/93		05/10/93		05/10/93		04/30/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Arsenic	15	0.5	7.2	0.5	5.0 J	0.5	6.0	0.5	5.9	0.5	7.4	0.6	4.9	0.5	8.2	0.5
Cyanide (Total)	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.8	ND	0.6	ND	0.6
Lead	12.3	0.2	16	0.2	13	0.2	10.2	0.2	12.0	0.2	12.7	0.3	8.5	0.2	16	0.2
Mercury	ND	0.02	0.02	0.02	ND J (e)	0.02	ND	0.02	0.02	0.02	0.04	0.03	ND	0.02	0.02	0.02
Moisture Content (Percent)	21	0.1	18	0.1	16	0.1	20	0.1	20	0.1	34	0.1	19	0.1	15	0.1
Selenium	ND	1.5	ND	1.5	ND	1.4	ND	1.5	ND	1.5	ND	1.8	ND	2.0	ND	1.9
Thallium	0.33	0.2	0.55	0.2	0.51	0.2	0.54	0.2	0.56	0.2	0.36	0.3	0.47	0.2	0.48	0.2
TARGET ANALYTE LIST																
Aluminum	12400	3.8	12100	3.6	10400	3.6	10800	3.8	16000	3.8	9400	4.5	8400	3.7	8000	3.5
Barium	130	0.6	88	0.6	88	0.6	190	0.6	108	0.6	180	0.8	140	0.6	130	0.6
Beryllium	1.0	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.8	ND	0.6	0.67	0.6
Cadmium	0.73	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.8	ND	0.6	ND	0.6
Calcium	2200	5.1	26000	4.9	18000	4.8	2000	5.0	1600	5.0	2300	6.1	2300	4.9	2400	4.7
Chromium	20	0.6	15	0.6	13	0.6	16	0.6	20	0.6	14.2	0.8	11.5	0.6	13	0.6
Cobalt	9.9	1	8.3	1	8.6	1	12.4	1	7.1	1	9.5	2	6.0	1	7.8	1
Copper	16	0.6	15	0.6	13	0.6	19	0.6	18	0.6	12.6	0.8	8.8	0.6	12	0.6
Iron	26000	2.5	20000	2.4	17000	2.4	20000	2.5	22000	2.5	15000	3.0	14000	2.5	18000	2.4
Magnesium	1800	3.8	17000	3.6	12000	3.6	2600	3.8	2600	3.8	1800	4.5	2000	3.7	1900	3.5
Manganese	420	0.6	580	0.6	690	0.6	580	0.6	320	0.6	610	0.8	760	0.6	1070	0.6
Nickel	11.8	1.9	11.0	1.8	10.6	1.8	15	1.9	11.2	1.9	8.8	2.3	7.2	1.8	10.5	1.8
Potassium	659	63	740	61	670	60	600	62	720	62	610	76	440	62	390	59
Antimony	ND J (eg)	5.1	ND J (eg)	4.9	ND J (eg)	4.8	ND J (eg)	5.0	ND J (eg)	5.0	ND J (eg)	6.1	ND	4.9	ND	4.7
Silver	1.6	0.6	1.8	0.6	0.96	0.6	1.08	0.6	1.09	0.6	0.86	0.8	1.10	0.6	1.3	0.6
Sodium	710	1.9	67	1.8	57	1.8	140	1.9	72	1.9	64	2.3	98	1.8	98	1.8
Vanadium	43	0.6	27	0.6	21	0.6	22	0.6	24	0.6	26	0.8	22	0.6	29	0.6
Zinc	71	1	45	1	43	1	59	1	51	1	115	2	31	1	32	1

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
EQ --- Elevated quantitation limits resulting from matrix interference.
J --- The associated value is an estimated quantity.
U --- The associated result is estimated as non-detect.
(a) --- Biased high due to surrogate recovery.
(b) --- Biased low due to surrogate recovery.
(c) --- Estimated due to surrogate recovery related to sample dilution.
(d) --- Biased high due to MS/MSD recovery.
(e) --- Biased low due to MS/MSD recovery.
(f) --- Biased high due to LCS recovery.
(g) --- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 15
Summary of Validated TAL Inorganic Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 14				SITE 16				SITE 20				SITE 22A			
Golder Sample ID	COSO1401		COSO1403		COSO1601		COSO1603		COSO2001		COSO2002		COSO22A01		COSO22A02	
Laboratory Sample ID	100358		100374		100277		100293		90492		90506		93769		93777	
Sample Depth (feet)	1.4 to 1.5		1.4 to 1.5		0.5 to 0.6		0.7 to 0.8		1.0 to 2.0		1.0 to 2.0		0.8 to 1.0		2.4 to 2.7	
Sample Type	Investigative		Investigative		Investigative		Investigative		Investigative		Duplicate of COSO2001		Investigative		Investigative	
Sample Date	05/05/93		05/05/93		05/04/93		05/04/93		04/28/93		04/28/93		04/30/93		04/30/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Arsenic	5.3	0.6	7.9	0.6	3.4	0.4	5.1	0.5	7.3	0.5	4.9	0.5	6.6	0.5	5.7	0.5
Cyanide (Total)	4.3	1	ND	1	ND	1	ND	1	ND	0.6	ND	0.6	ND	0.6	ND	0.6
Lead	150	0.3	22	0.3	9.6	0.2	24	0.3	50	0.2	11.2	0.2	24	0.2	15	0.2
Mercury	0.26	0.03	0.06	0.03	ND	0.02	0.04	0.03	ND	0.02	ND	0.02	0.04	0.02	ND	0.02
Moisture Content (Percent)	30	0.1	28	0.1	12	0.1	26	0.1	22	0.1	22	0.1	18	0.1	19	0.1
Selenium	ND	1.7	ND	1.7	ND	1.4	ND	1.6	ND	2.0	ND	2.0	ND	2.0	ND	2.0
Thallium	0.36	0.3	0.50	0.3	0.36	0.2	0.44	0.3	0.52	0.2	0.49	0.2	0.5	0.2	0.48	0.2
TARGET ANALYTE LIST																
Aluminum	10700	4.3	15000	4.2	8400	3.4	10900	4.0	1080	3.8	10600	3.8	7800	3.6	8300	3.7
Barium	230	0.7	111	0.7	109	0.6	105	0.7	140	0.6	150	0.6	330	0.6	150	0.6
Beryllium	1.04	0.7	ND	0.7	ND	0.6	ND	0.7	0.6	0.6	ND	0.6	0.68	0.6	ND	0.6
Cadmium	0.94	0.7	ND	0.7	0.9	0.6	4.2	0.7	0.74	0.6	0.69	0.6	0.8	0.6	ND	0.6
Calcium	4600	5.7	17000	5.6	53000	4.5	5400	5.4	1900	5.1	1900	5.1	1700	4.9	3100	4.9
Chromium	60	0.7	19	0.7	14	0.6	19	0.7	17	0.6	17	0.6	13	0.6	12	0.6
Cobalt	16	1	12.2	1	7.2	1	15	1	8.6	1	8.6	1	17	1	12.0	1
Copper	23	0.7	32	0.7	14	0.6	35	0.7	11.0	0.6	11.3	0.6	9.9	0.6	10.0	0.6
Iron	31000	2.8	21000	2.8	14000	2.3	19000	2.7	15000	2.6	17000	2.6	18000	2.4	15000	2.5
Magnesium	2000	4.3	7400	4.2	6400	3.4	2700	4.0	2200	3.8	2200	3.8	2300	3.6	1800	3.7
Manganese	1800	0.7	460	0.7	440	0.6	780	0.7	310	0.6	310	0.6	400	0.6	1600	0.6
Nickel	20	2.1	12.1	2.1	11	1.7	15	2.0	19	1.9	17	1.9	13	1.8	9.8	1.8
Potassium	570	71	620	69	400	57	570	68	440	64	550	64	360	61	460	62
Antimony	ND J (eg) 5.7		ND J (eg) 5.6		ND J (eg) 4.5		ND J (eg) 5.4		ND	5.1	ND	5.1	ND	4.9	ND	4.9
Silver	2.4	0.7	1.08	0.7	ND	0.6	1.18	0.7	1.5	0.6	1.5	0.6	1.5	0.6	1.4	0.6
Sodium	1360	2.1	119	2.1	89	1.7	80	2.0	200	1.9	200	1.9	72	1.8	68	1.8
Vanadium	37	0.7	29	0.7	19	0.6	28	0.7	22	0.6	23	0.6	35	0.6	26	0.6
Zinc	94	1	111	1	40	1	88	1	38	1	40	1	38	1	36	1

Notes:

- ND -- Not detected at or above the MDL.
MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
EQ -- Elevated quantitation limits resulting from matrix interference
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 15
Summary of Validated TAL Inorganic Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site Location	SITE 22A										SITE 36					
Golden Sample ID	COSO22A04	COSO22A07	COSO22A08	COSO22A13	COSO22A10	COSO22A11	COSE3601	COSE3609	COSL3603							
Laboratory Sample ID	93416	95206	95214	95249	95222	95230	103357	103438	100323							
Sample Depth (feet)	1.5 to 2.0	1.0 to 1.2	2.0 to 2.5	2.0 to 2.5	1.0 to 1.1	2.2 to 2.5	1.0 to 1.5	1.0 to 1.5	0.0 to 1.0							
Sample Type	Investigative	Investigative	Investigative	Duplicate of COSO22A08	Investigative	Investigative	Investigative	Duplicate of COSE3601	Investigative							
Sample Date	04/29/93	05/03/93	05/03/93	05/03/93	05/03/93	05/03/93	05/06/93	05/06/93	05/05/93							
Compound	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg	Conc. mg/Kg	MDL mg/Kg
Arsenic	7.0	0.5	4.2	0.5	5.6	0.5	6.4	0.5	6.0	0.6	3.5 J (d)	0.5	4.0	0.7	3.0	0.6
Cyanide (Total)	ND	0.6	ND	1	ND	1	ND	1	ND	1	ND	1	ND	2	ND	2
Lead	14	0.2	12.8	0.3	13	0.3	16	0.2	13.7	0.3	9.1	0.2	61	0.4	54	0.3
Mercury	0.04	0.02	0.04	0.03	0.04	0.03	0.02	0.02	0.04	0.03	0.04	0.02	0.26	0.04	0.24	0.03
Moisture Content (Percent)	21	0.1	24	0.1	24	0.1	23	0.1	29	0.1	22	0.1	43	0.1	34	0.1
Selenium	ND	2.0	ND	2.1	ND	2.1	ND	2.1	ND	2.2	ND J (e)	2	ND	2.8	ND	2.4
Thallium	0.47	0.2	0.42	0.2	0.55	0.3	0.51	0.2	0.49	0.3	0.4	0.2	0.47	0.4	0.42	0.3
TARGET ANALYTE LIST																
Aluminum	9100	3.8	6200	3.9	10300	3.9	9500	3.9	6500	4.2	12700	3.8	8400	5.3	7400	4.5
Barium	116	0.6	128	0.6	160	0.6	140	0.6	84	0.7	100	0.6	118	0.9	114	0.8
Beryllium	ND	0.6	0.6	0.6	ND	0.6	ND	0.6	ND	0.7	ND	0.6	ND	0.9	0.8	0.8
Cadmium	ND	0.6	ND	0.6	ND	0.6	ND	0.6	ND	0.7	ND	0.6	24	0.9	6.5	0.8
Calcium	2000	5.1	5100	5.3	4100	5.3	2800	5.2	24000	5.6	18300	5.1	3000	7.0	2900	6.1
Chromium	14	0.6	9.6	0.6	14	0.6	14	0.6	11.1	0.7	15	0.6	47	0.9	38	0.8
Cobalt	10.2	1	11.4	1	13	1	10.9	1	7.7	1	7.6	1	9.8	2	10.3	2
Copper	10.4	0.6	10.5	0.6	10.8	0.6	10.8	0.6	10.7	0.7	17	0.6	37	0.9	26	0.8
Iron	16000	2.5	12200	2.6	17000	2.6	16000	2.6	14000	2.8	22000	2.6	14900	3.5	18000	3.0
Magnesium	1900	3.8	1060	3.9	1600	3.9	1600	3.9	4800	4.2	3500	3.8	1680	5.3	1500	4.5
Manganese	890	0.6	1300	0.6	1600	0.6	1140	0.6	580	0.7	370	0.6	190	0.9	360	0.8
Nickel	11.6	1.9	10.6	2.0	14	2.0	11.3	1.9	10.7	2.1	14	1.9	17.4	2.6	12.3	2.3
Potassium	660	63	470	66	710	66	650	65	600	70	830	64	630	88	500	76
Antimony	ND	5.1	ND	5.3	ND	5.3	ND	5.2	ND	5.6	ND	5.1	ND J (eg)	7.0	ND	6.1
Silver	1.4	0.6	0.83	0.6	1	0.6	1.6	0.6	0.92	0.7	1.5	0.6	8.4	0.9	6.2	0.8
Sodium	56	1.9	64	2.0	72	2.0	66	1.9	82	2.1	100	1.9	210	2.6	180	2.3
Vanadium	26	0.6	26	0.6	29	0.6	27	0.6	30	0.7	29	0.6	23	0.9	27	0.8
Zinc	40	1	53	1	45	1	42	1	55	1	59	1	158	2	139	2

Notes:

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MDL -- Method Detection Limit
Conc. -- Concentration (dry-weight basis)
EQ -- Elevated quantitation limits resulting from matrix interference.
J -- The associated value is an estimated quantity.
U -- The associated result is estimated as non-detect.
(a) -- Biased high due to surrogate recovery.
(b) -- Biased low due to surrogate recovery.
(c) -- Estimated due to surrogate recovery related to sample dilution.
(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COSO22A01):

- CO -- Crab Orchard
SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- Site Number
01 -- Sample Number

TABLE 15
Summary of Validated TAL Inorganic Analyses of Soil, Sediment, and Sludge Samples
Phase I - RI, Miscellaneous Areas Operable Unit
Crab Orchard National Wildlife Refuge, Marion, Illinois

Site	SITE 36							
Location								
Golden Sample ID	COSL3604		COSL3605		COSL3606		COSL3607	
Laboratory Sample ID	100331		100340		100269		100250	
Sample Depth (feet)	0.0 to 1.0		0.0 to 1.0		0.0 to 1.0		0.0 to 1.0	
Sample Type	Investigative		Investigative		Investigative		Investigative	
Sample Date	05/05/93		05/05/93		05/04/93		05/04/93	
Compound	Conc.	MDL	Conc.	MDL	Conc.	MDL	Conc.	MDL
	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Arsenic	5.8	1.1	4.4	1	2.2	0.6	4.4 J (d)	0.6
Cyanide (Total)	ND	8.3	ND	2	ND	1	7.0	2
Lead	500	0.6	320	0.5	8.9	0.3	12.1	0.3
Mercury	3.0	0.06	1.7	0.05	0.03	0.03	0.08	0.03
Moisture Content (Percent)	64	0.1	59	0.1	29	0.1	34	0.1
Selenium	ND	3.3	0.93	0.7	ND	1.7	ND	2.4
Thallium	0.72	0.6	ND	0.5	0.39	0.3	0.48	0.3
TARGET ANALYTE LIST								
Aluminum	15800	8.3	13200	7.3	9300	4.2	9800	4.5
Barium	330	1.4	232	1.2	150	0.7	144	0.8
Beryllium	ND	1.4	ND	1.2	ND	0.7	ND	0.8
Cadmium	16.7	1.4	27	1.2	13.0	0.7	29	0.8
Calcium	11400	11.1	7600	9.8	2400	5.6	2300	6.1
Chromium	200	1.4	132	1.2	24	0.7	39	0.8
Cobalt	14.4	3	12.0	2	8.0	1	11.4	2
Copper	158	1.4	105	1.2	17	0.7	18	0.8
Iron	23900	5.6	19500	4.9	14000	2.8	17000	3.0
Magnesium	3000	8.3	2400	7.3	2100	4.2	2300	4.5
Manganese	1300	1.4	760	1.2	280	0.7	330	0.8
Nickel	36	4.2	32	3.6	22	2.1	24	2.3
Potassium	1080	139	850	122	450	70	700	76
Antimony	39 J (eg)	11.1	19.5 J (eg)	9.8	ND J (eg)	5.6	ND	6.1
Silver	108	1.4	63	1.2	1.01	0.7	2.9	0.8
Sodium	158	4.2	146	3.6	180	2.1	210	2.3
Vanadium	22.5	1.4	22.2	1.2	18	0.7	30	0.8
Zinc	800	3	630	2	127	1	170	2

Notes:

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Conc. -- Concentration (dry-weight basis)
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(d) -- Biased high due to MS/MSD recovery.
(e) -- Biased low due to MS/MSD recovery.
(f) -- Biased high due to LCS recovery.
(g) -- Biased low due to LCS recovery.

Sample ID Breakdown (COS022A01):

- CO -- CO -- Crab Orchard
SO -- SO -- Soil / SE-- Sediment / SL-- Sludge
22A -- 22A -- Site Number
01 -- 01 -- Sample Number

Created: SK
Reviewed: RP
Checked: MD

TABLE 16
PRELIMINARY LEVELS OF CONCERN AND
ADJUSTED PRELIMINARY LEVELS OF CONCERN
FOR ORGANIC COMPOUNDS

DETECTED ORGANIC ANALYTE	Residential Exposure Scenario (1)		Residential Exposure Scenario (2)		LUST VALUE	ROD VALUE	PRELIMINARY LEVEL OF CONCERN (SOIL) (ug/kg)	ADJUSTED PRELIMINARY LEVEL OF CONCERN (SOIL) (ug/kg)
	RfD (mg/kg-d)	VALUE (ug/kg)	SF (mg/kg-d)-1	VALUE (ug/kg)				
VOLATILES								
Acetone	0.100 (I)	8240000					8240000	NA
BETX (Total) (3)					11705		11705	NA
Ethylbenzene	0.100 (I)	8240000			<11705 (3)		<11705	NA
Methylene Chloride	0.060 (I)	4944000	0.0075 (I)	85333			85333	NA
Methyl ethyl ketone (2-Butanone)	0.050 (H)	4120000					4120000	NA
Toluene	0.200 (I)	16480000			<11705 (3)		<11705	NA
Xylenes (total)	2.000 (I)	16480000			<11705 (3)		<11705	NA
SEMIVOLATILES								
Acenaphthene	0.060 (I)	4944000			8400		8400	1680
Anthracene	0.300 (I)	24720000			42000		42000	8400
Benzo(a)anthracene					<4 (4)		<4	<0.8
Benzo(a)pyrene			7.3 (I)	88	<4 (4)		<4	<0.8
Benzo(b)fluoranthene					<4 (4)		<4	<0.8
Bis(2-ethylhexyl)phthalate (DEHP)	0.020 (I)	1648000	0.014 (I)	45714			45714	9143
Chrysene					<4 (4)		<4	<0.8
Di-n-butylphthalate	0.100 (I)	8240000					8240000	1640000
Dibenzofuran							NE	NA
Fluoranthene	0.040 (I)	3296000			5600		5600	1120
Fluorene	0.040 (I)	3296000			5600		5600	1120
2-Methylnaphthalene	0.004 (S****)	329600					329600	65920
Napthalene	0.004 (S)	329600			25		25	5.0
Pentachlorophenol	0.030 (I)	2472000	0.12 (I)	5333			5333	1063
Phenanthrene	0.030 (I****)	2472000			<4200 (5)		<4200	<840
Pyrene	0.030 (I)	2472000			4200		4200	840
Total Carcinogenic PNAs (4)					4		4	0.8
Total Non-Carcinogenic PNAs (5)					4200		4200	840
EXPLOSIVES								
2,4,6-Trinitrotoluene (TNT)							NE	NA
PESTICIDES AND PCBs								
Aldrin	0.00003 (I)	2472	17.0 (I)	38			38	7.6
4,4'-DDD			0.24 (I)	2667			2667	534
4,4'-DDE			0.34 (I)	1882			1882	376
4,4'-DDT	0.0005 (I)	41200	0.34 (I)	1882			1882	376
Heptachlor Epoxide							NE	NA
Total PCBs (6)						500	500	100
Aroclor-1248			7.7 (I)	83	<500 (6)		<500	<100
Aroclor-1254			7.7 (I)	83	<500 (6)		<500	<100
Aroclor-1260			7.7 (I)	83	<500 (6)		<500	<100
DIOXINS/FURANS								
Total Dioxins/Furans (7)							1.0 (8)	0.2

NOTES:

- (1) Assuming a Hazard Quotient of 0.3 and oral exposure route.
- (2) Assuming an Incremental Cancer Risk of 1E-06 and oral exposure route.
- (3) Total BETX is the sum of benzene, ethylbenzene, toluene, and xylene concentrations.
- (4) Total Carcinogenic PNAs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene
- (5) Total Non-Carcinogenic PNAs include phenanthrene, acenaphthylene, and benzo(g,h,i)perylene
- (6) Total PCBs includes all Aroclor species.
- (7) Total Dioxins/Furans include 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,8-OCDD, 1,2,3,6,7,8-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF
- (8) USEPA Region VII Preliminary Recommended Standard

I = IRIS

H = Heast

S = Superfund Technical Support Center

*** = Based on Pyrene surrogates

**** = Based on Naphthalene surrogate

LUST = Leaky Underground Storage Tank Program (IEPA, 1991)

ROD = EPA Records of Decisions (PCB and Metals Operable Unit)

NE = Not Established

TABLE 17
PRELIMINARY LEVELS OF CONCERN AND
ADJUSTED PRELIMINARY LEVELS OF CONCERN
FOR INORGANIC ANALYTES

INORGANIC ANALYTE	Residential Exposure Scenario (1)		Residential Exposure Scenario (2)		BACKGROUND (3) UPPER LIMIT OF RANGE (mg/kg)	RECORD OF DECISIONS VALUE (4) (mg/kg)	PRELIMINARY LEVEL OF CONCERN (mg/kg)	ADJUSTED PRELIMINARY LEVEL OF CONCERN (mg/kg)
	RfD (mg/kg-d)	VALUE (mg/kg)	SF (mg/kg-d)-1	VALUE (mg/kg)				
Aluminum	1.000 (S)	82400			28700		82400	NA
Antimony	0.000 (I)	33			2.41		33	NA
Arsenic	0.000 (I)	24.7	1.7 (I*)	0.38	15.50		15.50	NA
Barium	0.070 (I)	5768			160		5768	NA
Beryllium	0.005 (I)	412	4.3 (I)	0.15	0.86		0.86	NA
Cadmium	0.001 (I)	82.4			1.35	10	1.35	NA
Calcium	NT		NT		2250		NT	NA
Chromium	0.005	412.0			42.90		412	NA
Cobalt	0.060 (S)	4944			18.60		4944	NA
Copper	0.040 (S)	3296			21.10		3296	NA
Iron	NT		NT		30800		NT	NA
Lead	ND		ND		19.50	450	450	NA
Magnesium	NT		NT		1130		NT	NA
Manganese	0.140 (I)	11536			1340		11536	NA
Mercury	0.000 (H)	24.7			0.06		24.7	NA
Nickel	0.020 (I)	1648			34.80		1648	NA
Potassium	NT		NT		1590		NT	NA
Selenium	0.005 (I)	412			1.50		412	NA
Silver	0.005 (I)	412			0.80		412	NA
Sodium	NT		NT		451		NT	NA
Thallium					0.63		0.63	NA
Vanadium	0.007 (H)	576.8			96		577	NA
Zinc	0.300 (I)	24720			208		24720	NA
Total Cyanide	0.020 (I)	1648			NA		1648	330

(1) Assuming a Hazard Quotient of 0.3 and oral exposure route. RfD = Reference Dose.

(2) Assuming an Incremental Cancer Risk of 1E-06 and oral exposure route. SF = Slope Factor.

(3) USACE, 1992. See Section 3.4.3 of this report for more information.

(4) Record Of Decision Values established by the EPA for the PCB and Metals Operable Units (USEPA, 1990a and b).

* = Based on proposed arsenic unit risk of 5E-05 ug/l (IRIS; EPA 1992c).

I = IRIS

H = Heast

S = Superfund Technical Support Center

NA = Not Applicable

ND = No Data

NT = Parameter considered non-toxic under typical environmental exposure scenarios (USEPA, 1989), and not evaluated for soil pathways

TABLE 18

SUMMARY OF CONSTITUENTS DETECTED DURING 1993 PHASE-I INVESTIGATION

SITE	TCL VOCs	TCL SVOCs	TCL PEST/ PCBs	EXPLOSIVES	DIOXINS	TAL
Site 7					NA	XXX
Site 7A					NA	
Site 8	X				NA	XXX
Site 9					NA	XXX
Site 10	X	XXX			NA	
Site 11	X				NA	XXX
Site 11A	X		XX	XX	NA	
Site 12	X	X			NA	
Site 14	XXX	X			NA	XXX
Site 16	X		XXX		NA	XXX
Site 20					NA	
Site 22A	X	XXX	X		XXX	
Site 36	X	XXX	XXX		NA	XXX

XXX - Detectable Concentrations above the Preliminary Level of Concern or Adjusted Preliminary Level of Concern
 XX - Detectable Concentration of Compound for which no Preliminary Level of Concern is established
 X - Detectable Concentrations of Organic Compounds
 NA - Not Analyzed

December1993

923-8108

TABLE 19
PRIMARY MEDIA POTENTIALLY IMPACTED
BY RELEASE OF COMPOUNDS OF CONCERN

Release Source	Pathway	Primary Media Impacted
Soils	Volatization	Air
	Fugitive Dust Generation	Surface Soil
	Foot Traffic	Surface Soil
	Surface Runoff	Sediment & Surface Soil
	Leaching	Ground & Surface Water
Sediment	Episodic Overbank Flow	Surface Soil
	Bedload Transport	Sediment
	Leaching	Underlying Soils, Surface Water & Groundwater
	Foot Traffic	Surface Soil
Sludge	Episodic Overbank Flow	Surface Soils
	Leaching	Underlying Soils, Surface Water & Groundwater

(08716438.wp1/srh)

TABLE 20
INDICATOR SCORES

<u>Indicator Compounds</u>	<u>Maximum Sample Concentration (mg/kg)</u>	<u>Toxicity Constant¹ (kg/mg)</u>	<u>Indicator Score²</u>
Benzo(a)anthracene	3.9 ³	2.9×10^{-5}	.00011
Bis(2-ethylhexyl)phthalate	1.2 ³	2.86×10^{-8}	3.4×10^{-8}
PCBs (total)	129.8 ³	2.86×10^{-5}	.00371
Dioxin/furans (total)	0.778 ⁴	1.71×10^{-1}	.133

¹ Based on oral route for soil, from USEPA (1986, Exhibit A-3). Toxicity constant shown for total dioxins/furans is toxicity constant for the dioxin 2,3,7,8 - TCDD.

² Indicator score is sum of maximum sample concentration and toxicity constant. Indicator score is unitless.

³ Sample COSL3604/00.' to 1.0'

⁴ Sample COSO22A03/0.6' to 0.8'

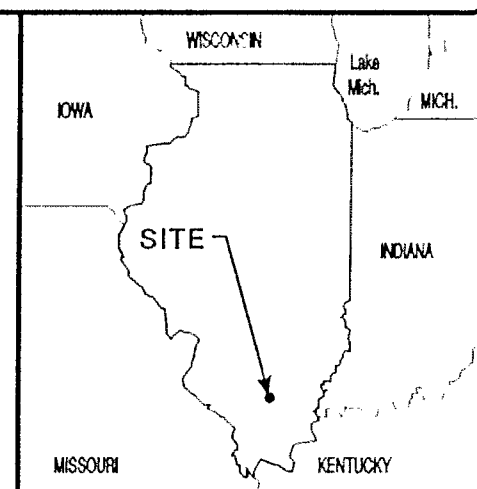
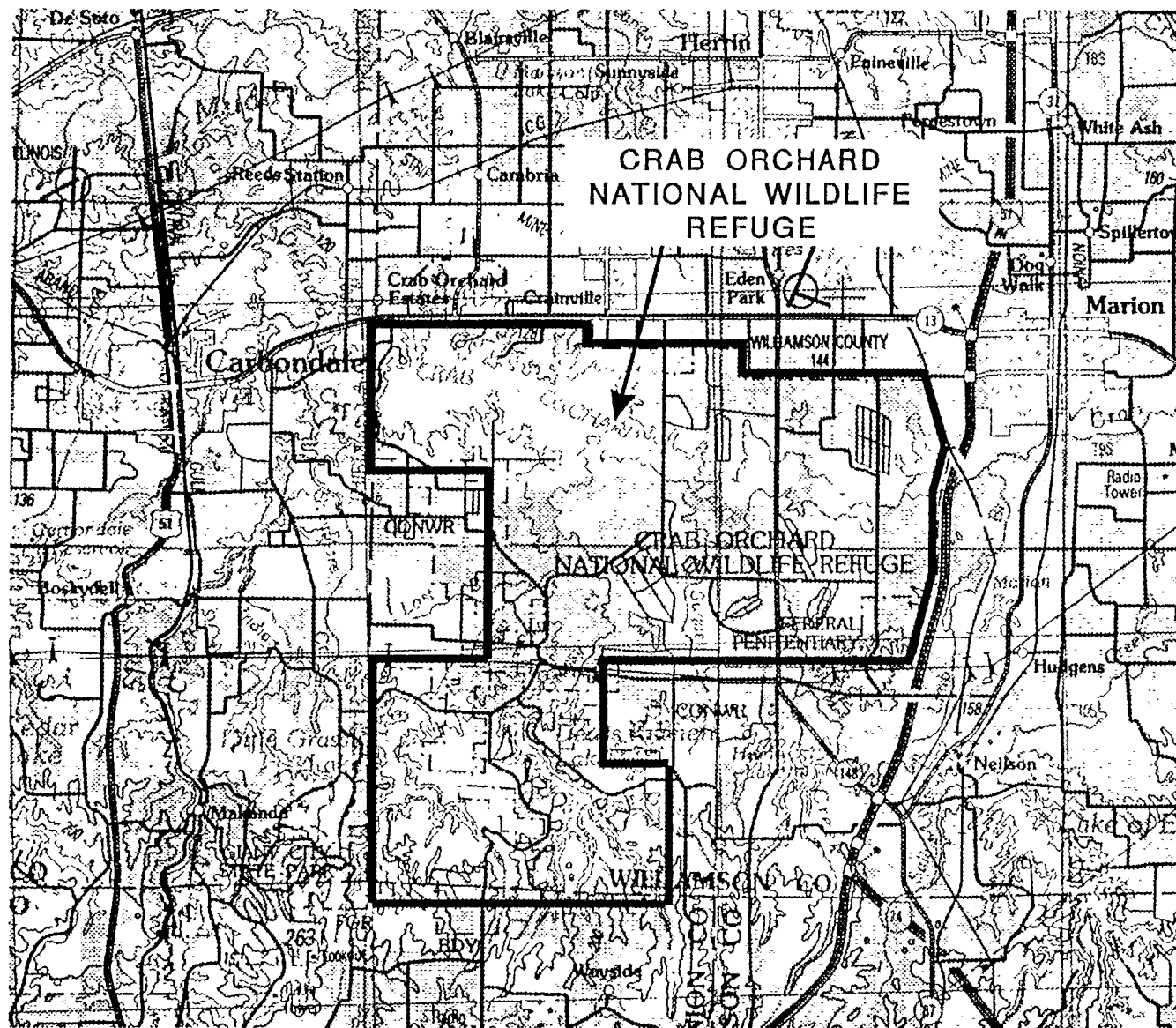
(08726720.wp1/srh)

TABLE 21
PHYSICAL PROPERTIES OF INDICATOR COMPOUNDS

<u>Compound</u>	<u>Log K_{ow} (no units)</u>	<u>Water Solubility (mg/l)</u>	<u>Vapor Pressure (mmHg)</u>
Acetone	-0.24	1.00x10 ⁶	2.70x10 ²
Benzo(a)anthracene	5.60	5.70x10 ⁻³	2.20x10 ⁻⁸
Dioxin(2,3,7,8-TCDD)	6.72	2.00x10 ⁻⁴	1.70x10 ⁻⁶
Ethylbenzene	3.15	1.52x10 ²	7.0x10 ⁰
Polychlorinated Biphenols	6.04	3.10x10 ⁻²	7.70x10 ⁻⁵
Pyrene	4.88	1.32x10 ⁻¹	2.50x10 ⁻⁶
Trinitrotoluene (TNT)	NA	2x10 ²	NA
Xylenes	3.26	1.98x10 ²	1x10 ¹

K_{ow} = Octanol/water partition coefficient; NA = not available

Data from USEPA, 1986, Exhibit A-1 and A-3; except TNT from Verschueren (1983)

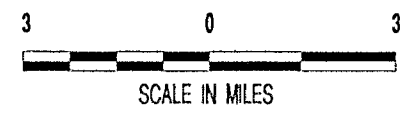



VICINITY MAP

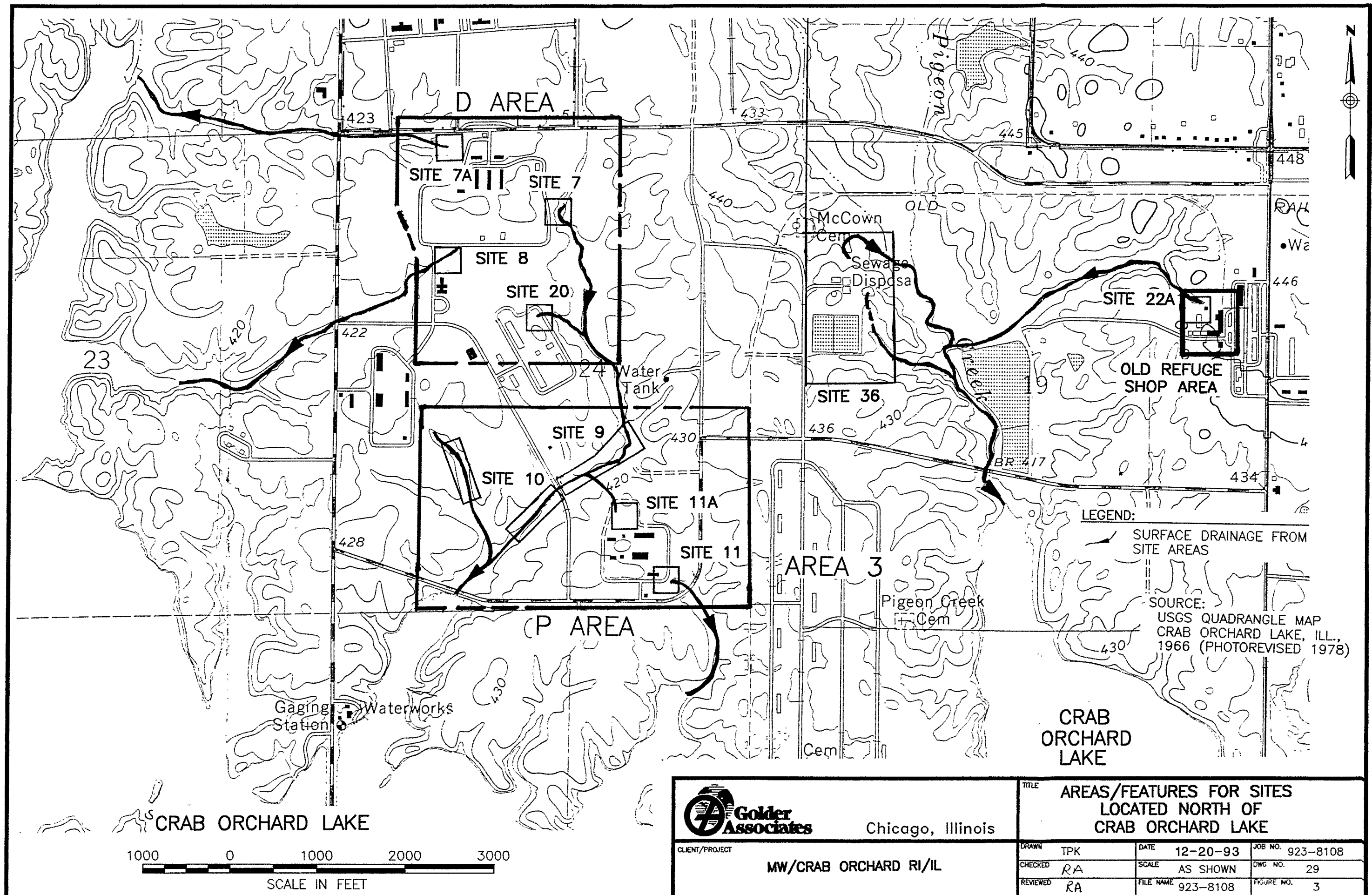
SOURCE:
PADUCAH
1 X 2 QUADRANGLE
GEOLOGICAL SURVEY
1987

NOTE:
1. REFUGE BOUNDARY
LOCATION APPROXIMATE.

SITE PLAN



CLIENT/PROJECT		 Golder Associates Chicago, Illinois		TITLE			
MW/CRAB ORCHARD RI/IL				REFUGE LOCATION MAP			
DRAWN	CHECKED	DATE	SCALE	FILE NAME	JOB NO.	DWG NO.	FIGURE
KMK	RA	12-20-93	AS SHOWN	8108149	923-8108		1



1000 0 1000 2000 3000
SCALE IN FEET



Chicago, Illinois

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

TITLE

AREAS/FEATURES FOR SITES
LOCATED NORTH OF
CRAB ORCHARD LAKE

DRAWN

TPK

DATE

12-20-93

JOB NO.

923-8108

CHECKED

RA

SCALE

AS SHOWN

DWG NO.

29

REVIEWED

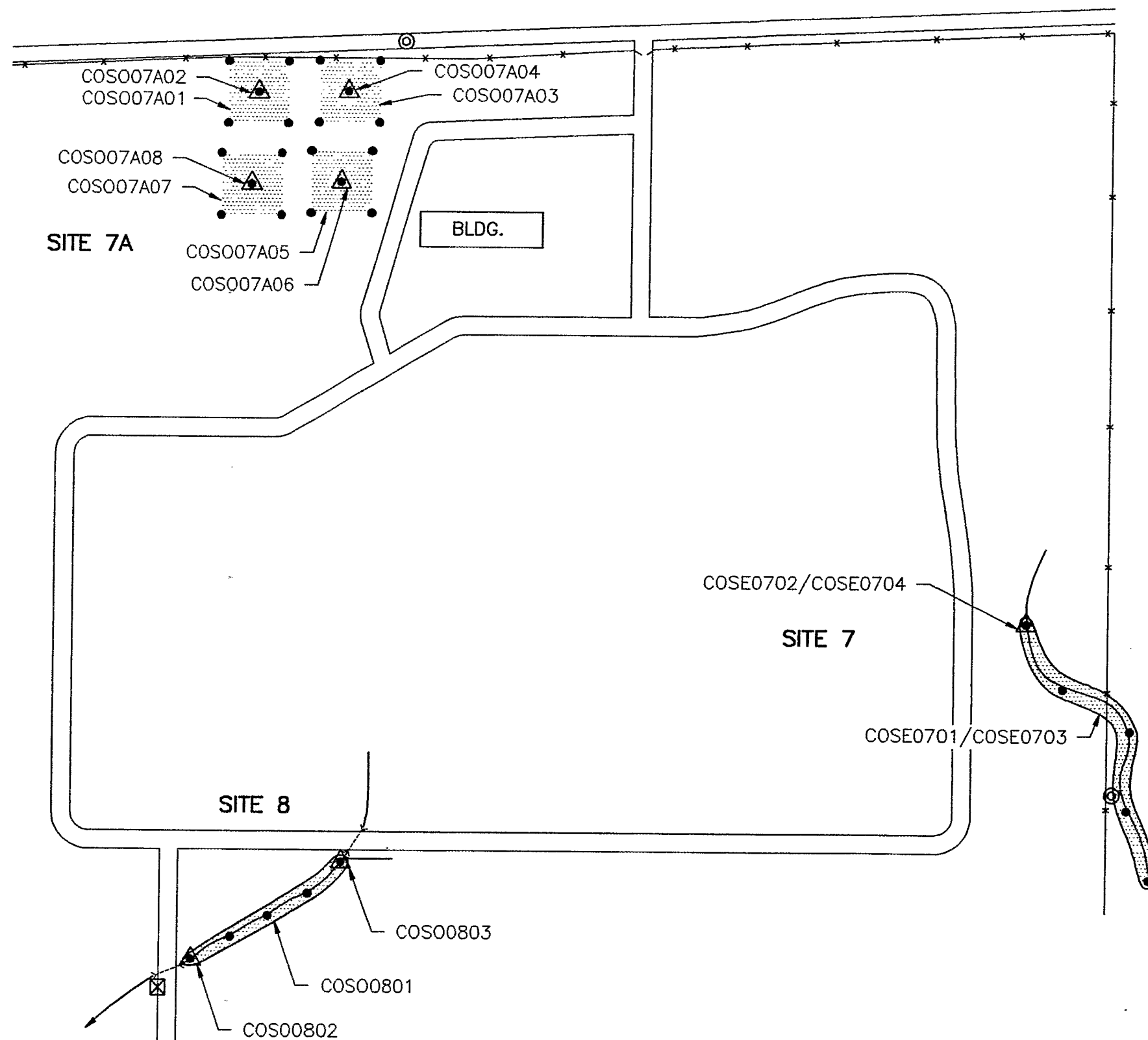
RA

FILE NAME

923-8108

FIGURE NO.

3

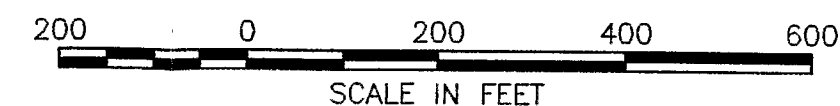


LEGEND:

- COS007A02
△ DISCRETE SAMPLE LOCATION
- COS007A01
○ GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE GRAB SAMPLES
- *— FENCE
- ROAD
- X— CULVERT
- ↗ SURFACE FLOW DIRECTION
- ⊙ IRON SURVEY PIN
- ⊠ WOOD SURVEY STAKE

NOTE:

1. SAMPLES COSE0703 AND COSE0704 ARE SAMPLE SPLITS OF COSE0701 AND COSE0702, RESPECTIVELY.



Chicago, Illinois

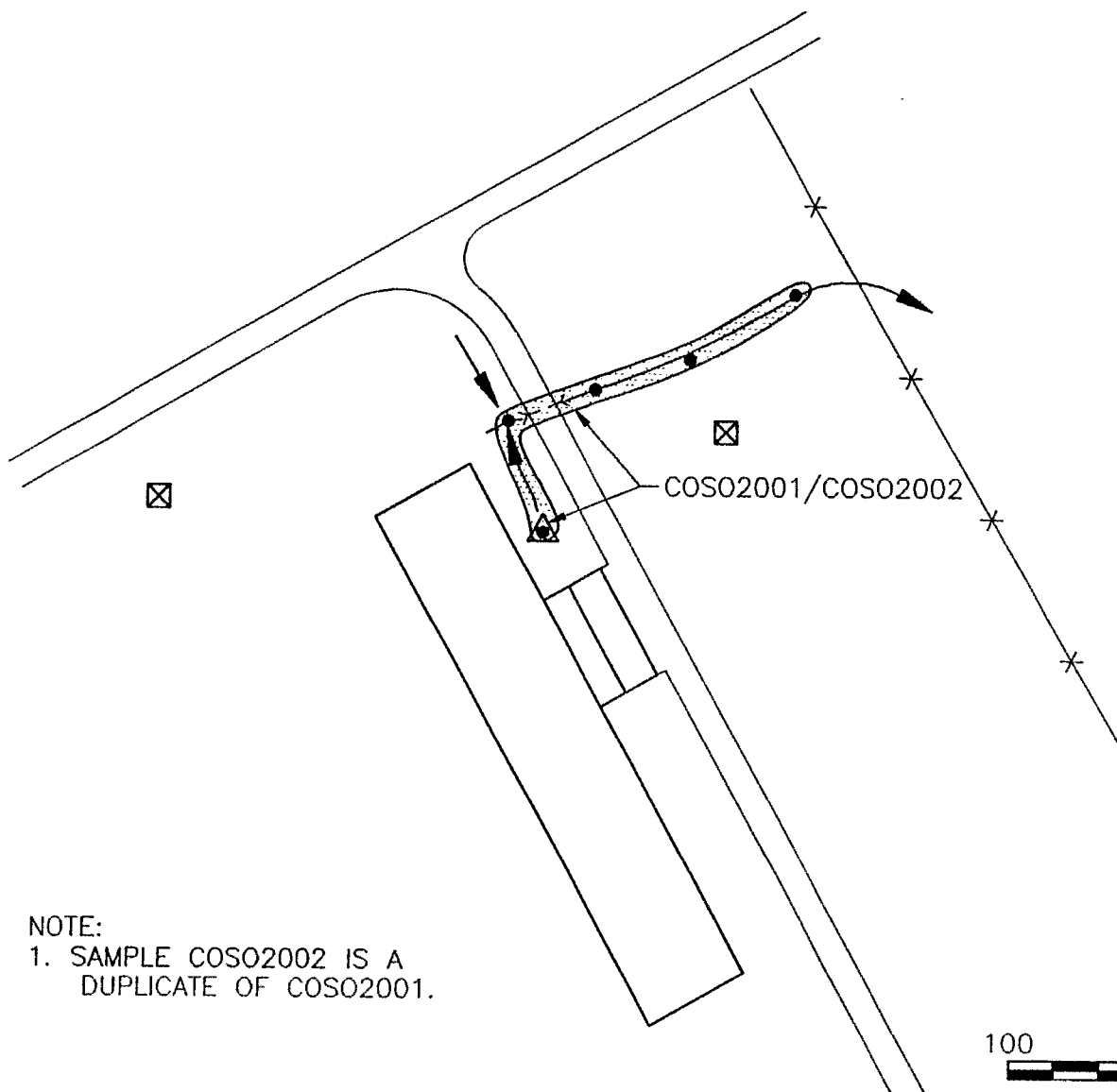
CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL


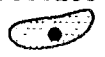

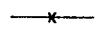


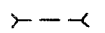

TITLE

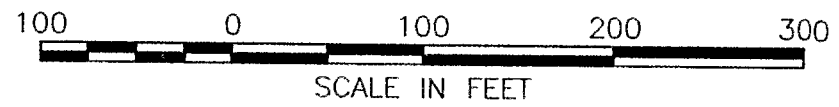
SITES 7, 7A AND 8
PHASE-I SAMPLE LOCATIONS


DRAWN	TPK	DATE	12-20-93	JOB NO.	923-8108
CHECKED	RA	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	RA	FILE NAME	8108120	FIGURE NO.	5

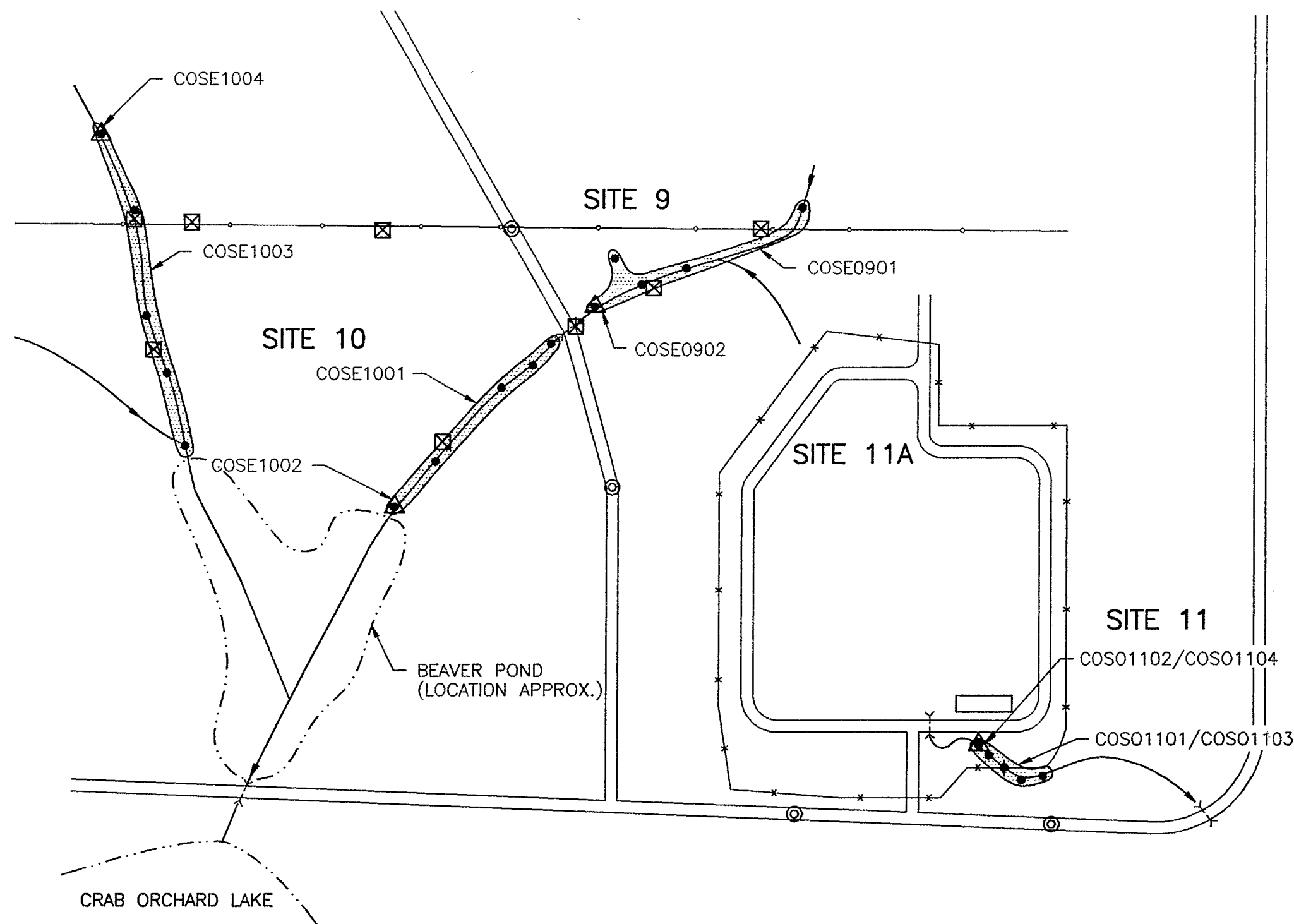


LEGEND:

- COSO2001  DISCRETE SAMPLE LOCATION
- COSO2001  GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE GRAB SAMPLES
-  WOOD SURVEY STAKE
-  FENCE
-  BUILDING/STRUCTURE
-  ROAD
-  CULVERT
-  SURFACE FLOW DIRECTION

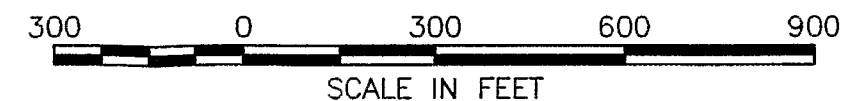


CLIENT/PROJECT MW/CRAB ORCHARD RI /IL			 Golder Associates Chicago, Illinois			TITLE SITE 20 PHASE-I SAMPLE LOCATIONS		
DRAWN TPK	CHECKED <i>RA</i>	REVIEWED <i>RA</i>	DATE 12-20-93	SCALE AS SHOWN	FILE NAME 8108122	JOB NO. 923-8108	DWG NO.	FIGURE 6



LEGEND:

- COSE1004 DISCRETE SAMPLE LOCATION
- COSE1003 GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE GRAB SAMPLES
- POWER LINE
- FENCE
- BUILDING/STRUCTURE
- ROAD
- CULVERT
- SURFACE FLOW DIRECTION
- IRON SURVEY PIN
- WOOD SURVEY STAKE



NOTE:
1. SAMPLES COS01103 AND COS01104 ARE
SAMPLE SPLITS OF COS01101 AND
COS01102, RESPECTIVELY.



Chicago, Illinois

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

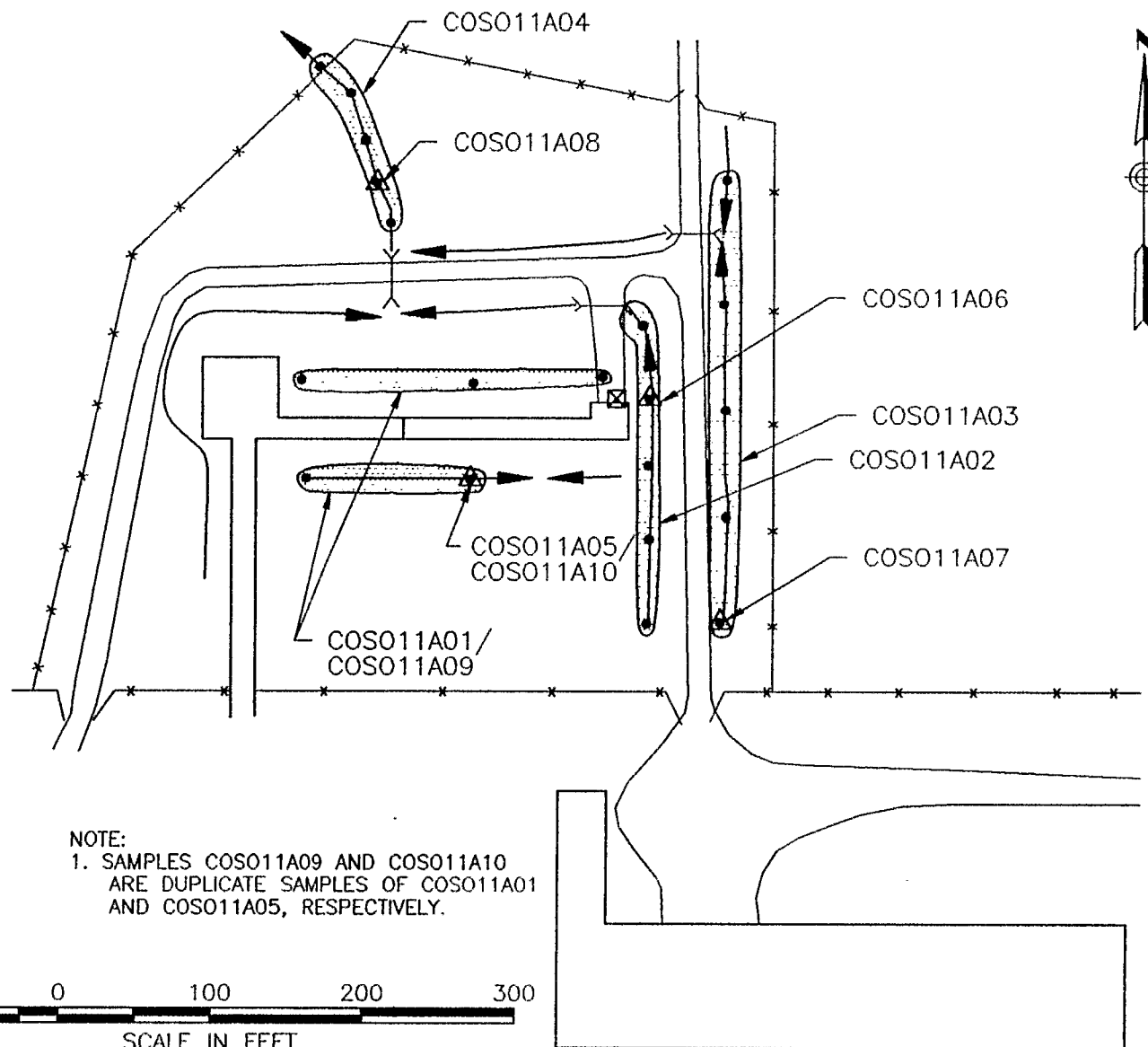
TITLE

SITES 9, 10, AND 11
PHASE-I SAMPLE LOCATIONS

DRAWN	TPK	DATE	12-21-93	JOB NO.	923-8108
CHECKED	PA	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	PA	FILE NAME	8108121	FIGURE NO.	7

LEGEND:

- COSO11A08
△ DISCRETE SAMPLE LOCATION
- COSO11A04
○ GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE GRAB SAMPLES
- SURFACE FLOW DIRECTION
- BUILDING/STRUCTURE
- > CULVERT
- ROAD
- *— FENCE
- ⊠ WOOD SURVEY STAKE



NOTE:
1. SAMPLES COSO11A09 AND COSO11A10
ARE DUPLICATE SAMPLES OF COSO11A01
AND COSO11A05, RESPECTIVELY.

CLIENT/PROJECT

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TITLE

SITE 11A
PHASE-I SAMPLE LOCATIONS

DRAWN

TPK

CHECKED

RA

REVIEWED

RA

DATE

12-20-93

SCALE

AS SHOWN

FILE NAME

8108107

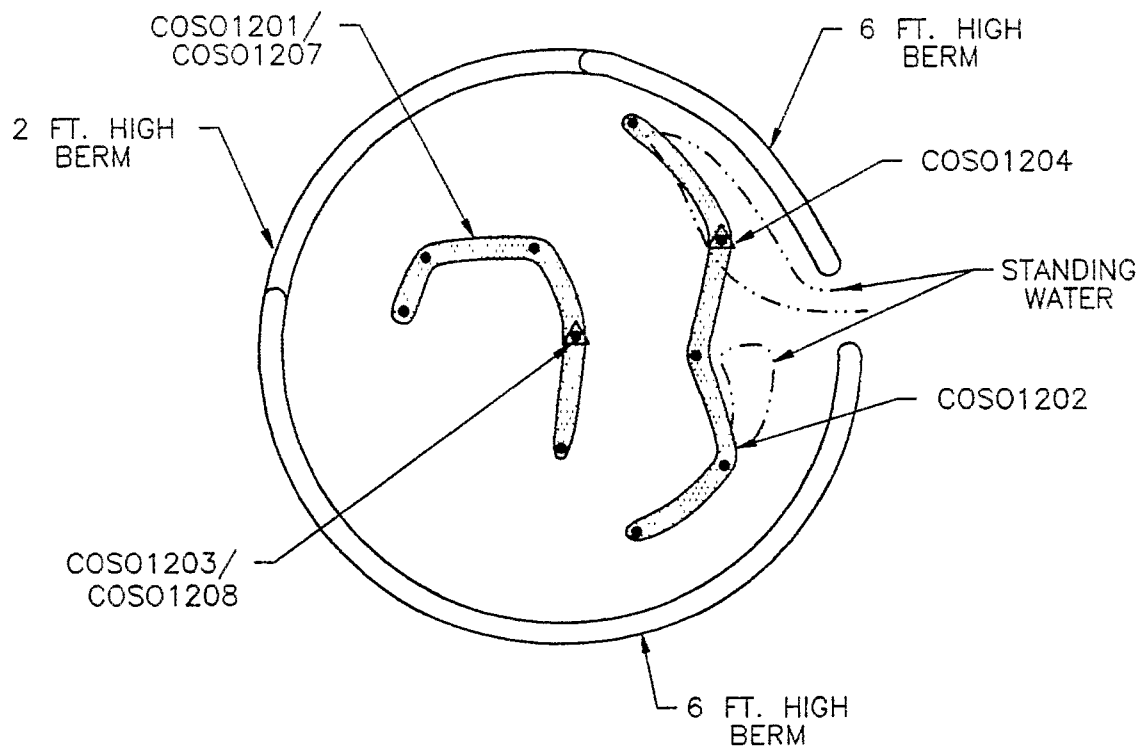
JOB NO.

923-8108

DWG NO.

FIGURE



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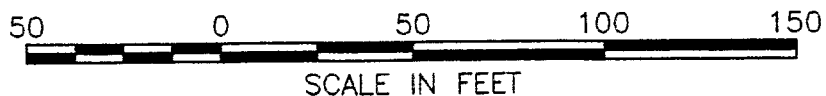


NOTE:

1. SAMPLES COSO1207 AND COSO1208 ARE DUPLICATES OF COSO1201 AND COSO1203, RESPECTIVELY.

LEGEND:

- COSO1203  DISCRETE SAMPLE LOCATION
- COSO1201  GENERAL AREA OF COMPOSITE SAMPLE



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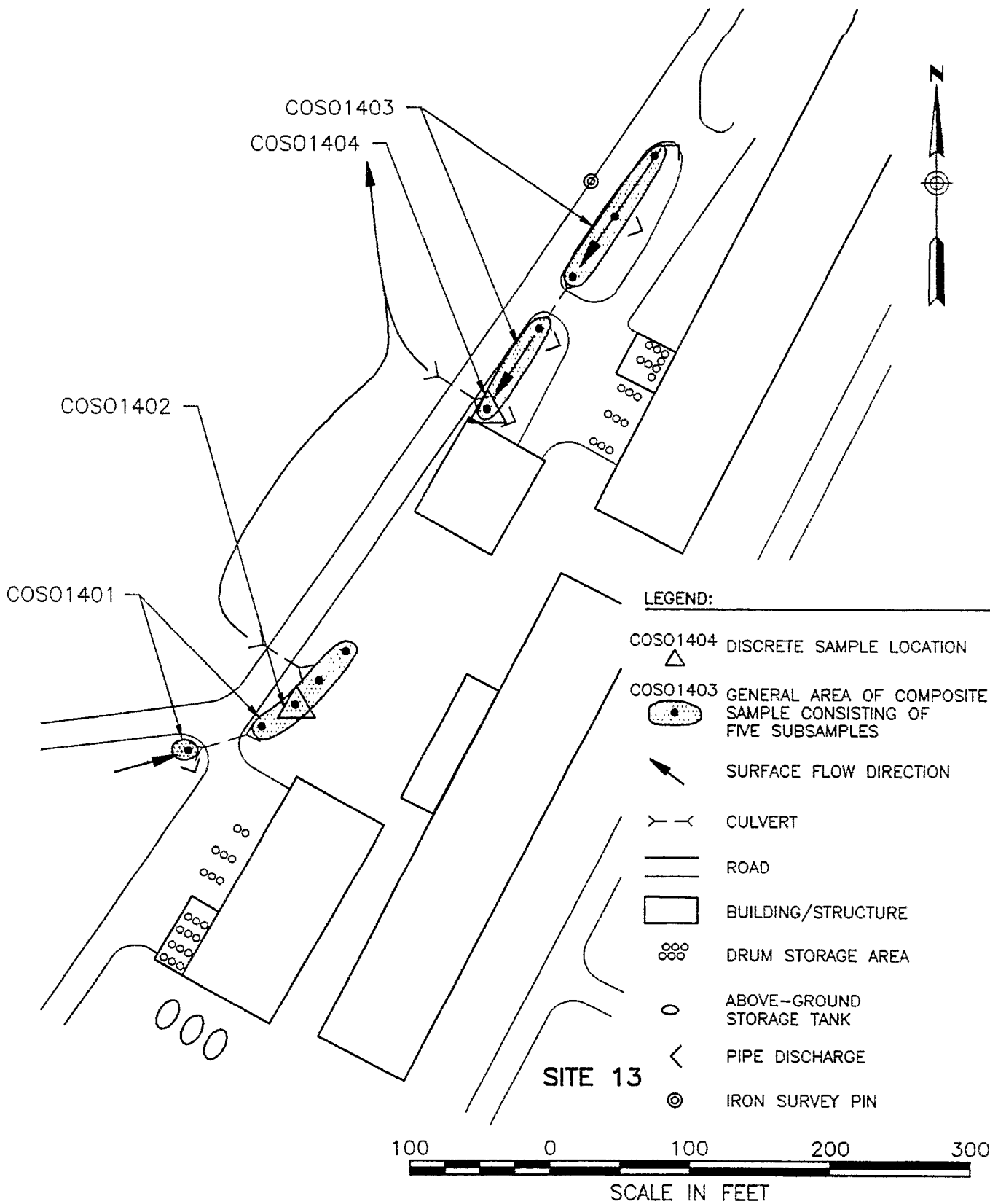
CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

TITLE

SITE 12
PHASE-I SAMPLE LOCATIONS

DRAWN	TPK	DATE	12-17-93	JOB NO.	923-8108
CHECKED	RA	SCALE	AS SHOWN	DWG NO.	
REVIEWED	2A	FILE NAME	8108119	FIGURE NO.	9



Chicago, Illinois

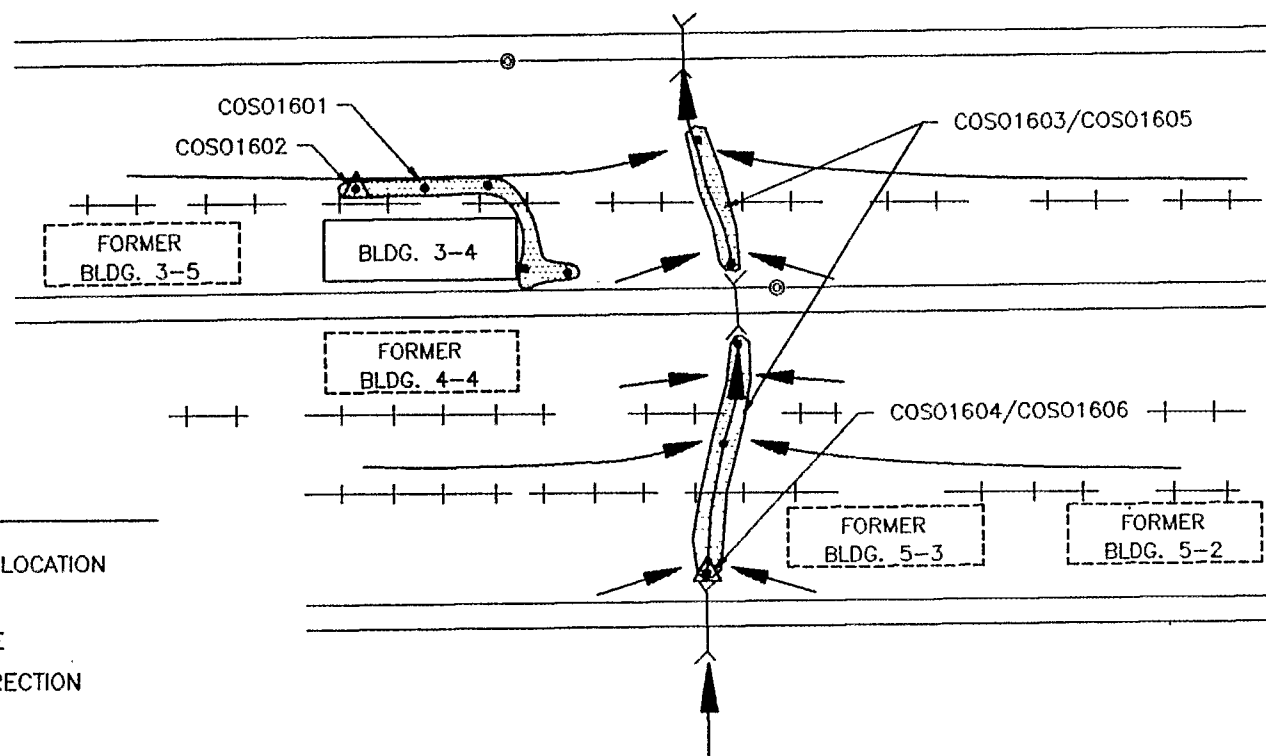
CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

TITLE

SITE 14 PHASE-I SAMPLE LOCATIONS

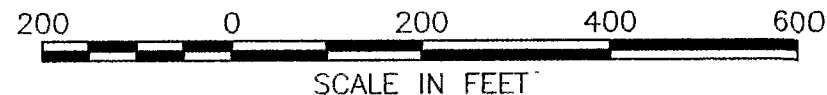
DRAWN	TPK	DATE	12-22-93	JOB NO.	923-8108
CHECKED	<i>Wet</i>	SCALE	AS SHOWN	CDWG NO.	
REVIEWED	<i>Wet</i>	FILE NAME	8108111	FIGURE NO.	10



LEGEND:

- COS01602
▲ DISCRETE SAMPLE LOCATION
- COS01601
● GENERAL AREA OF COMPOSITE SAMPLE
- ➔ SURFACE FLOW DIRECTION
- <— CULVERT
- + + + FORMER RAILROAD SPUR
- ▭ EXISTING BUILDING OF INTEREST
- - - RAZED BUILDING
- ⊙ IRON SURVEY PIN

NOTE:
1. SAMPLES COS01605 AND COS016016 ARE SAMPLE SPLITS OF COS01603 AND COS01604, RESPECTIVELY.



CLIENT/PROJECT

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TITLE

SITE 16
PHASE-I SAMPLE LOCATIONS

DRAWN

TPK

CHECKED

RA

REVIEWED

RA

DATE

12-20-93

SCALE

AS SHOWN

FILE NAME

8108112

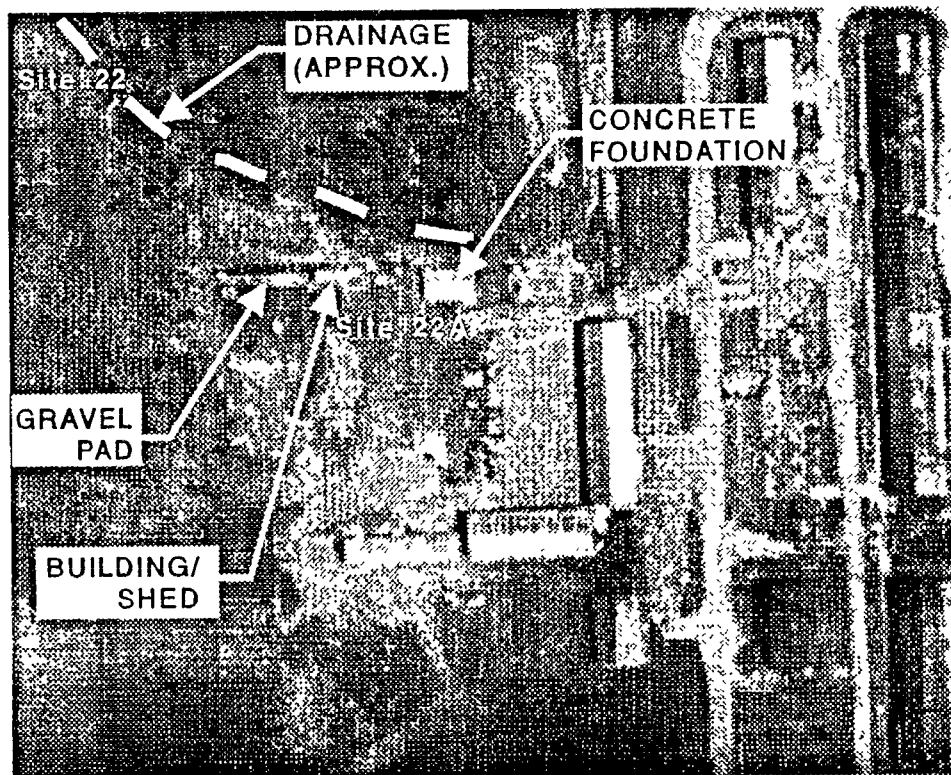
JOB NO.

923-8108

DWG NO.

FIGURE

11



SOURCE: PHOTOGRAPH BHK-3W-85 TAKEN
MAY 1, 1960 SCALE RATIO 1:20,000
(USDA, 1960)

120 0 120
APPROXIMATE SCALE IN FEET

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL



Chicago, Illinois

TITLE

1960 AERIAL PHOTOGRAPH
SHOWING POST TREATING
FACILITY FEATURES

DRAWN

KMK

CHECKED

W60

REVIEWED

W61

DATE

12-21-93

SCALE

AS SHOWN

FILE NAME

8108155

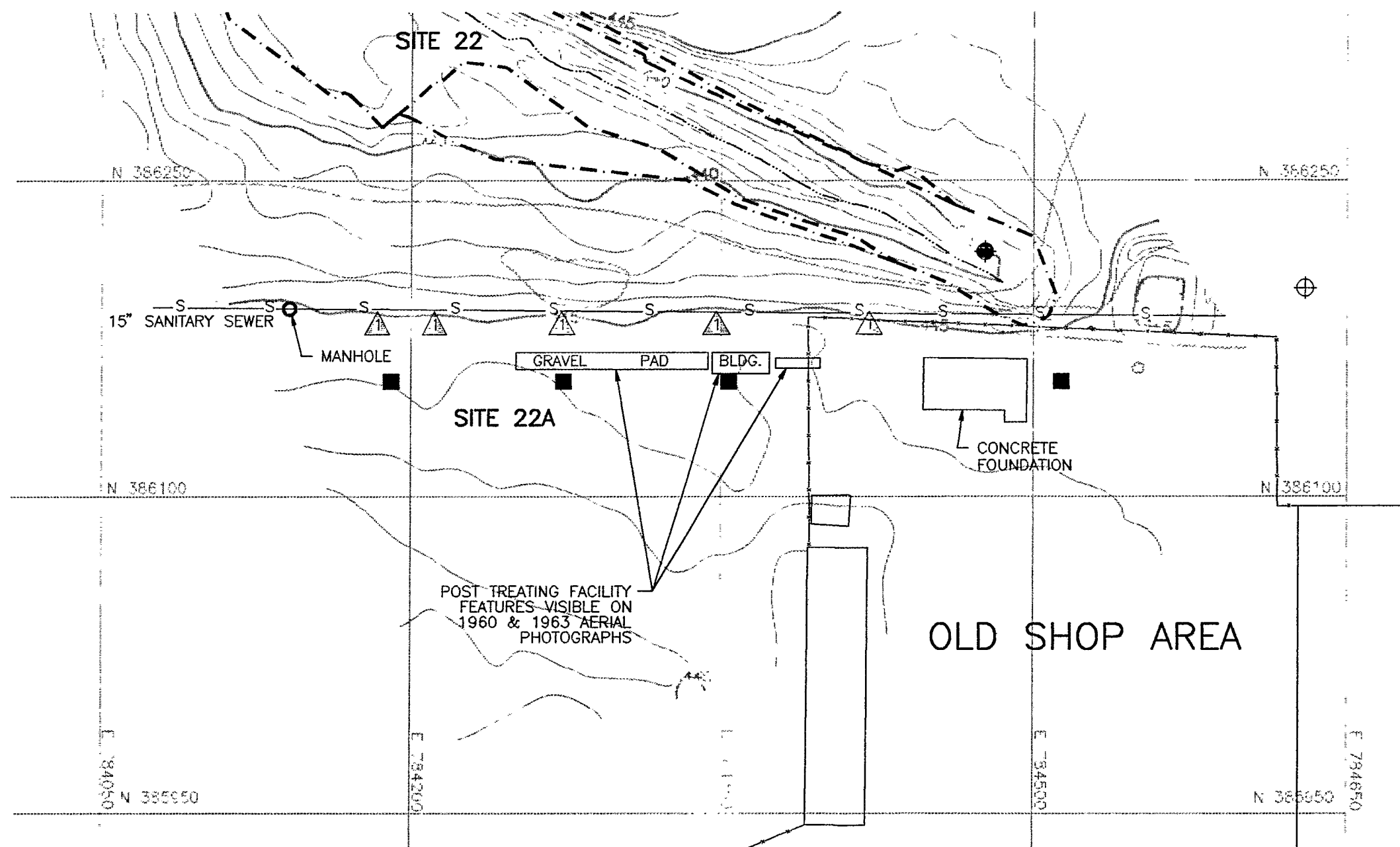
JOB NO.

923-8108

DWG NO.

FIGURE

12



LEGEND:

PHASE I AND PREVIOUS SAMPLING LOCATIONS

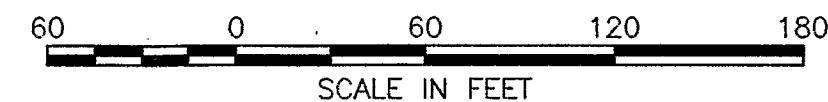
- GENERAL AREA OF COMPOSITE SOIL SAMPLE CONSISTING OF FIVE GRAB SAMPLES
- ▲ GENERAL AREA OF SAMPLE COLLECTED BY USFWS 1989 (APPROX. LOCATION)
- MONITORING WELL INSTALLED FOR 1988 RI

OTHER FEATURES

- ⊕ GENERAL LOCATION OF RA MONITORING WELL (SITE 22)
- x- FENCE
- BUILDING OR FOUNDATIONS
- S- SANITARY SEWER
- .- METALS AREA OPERABLE UNIT REMEDIAL DESIGN RD EXCAVATION BOUNDARY
- ~~~~~ TREE LINE (TYP.)

NOTES:

1. GRID IS IN FEET AND RELATIVE TO ILLINOIS STATE PLANE COORDINATES.
2. CONTOUR ELEVATIONS ARE IN FEET AND RELATIVE TO MEAN SEA LEVEL.
3. CONTOUR INTERVAL IS ONE FOOT.
4. BASE MAP FROM DRAWING CER 61-400E, SHEET REF. NO. C4, DATED FEB., 1993, BY WOODWARD-CLYDE CONSULTANTS.



Chicago, Illinois

TITLE POST TREATING FACILITY (SITE 22A) PHASE I SAMPLE LOCATIONS

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

DRAWN

TPK

DATE

12-22-93

JOB NO. 923-8108

CHECKED

WBB

SCALE

AS SHOWN

DWG. NO.

REVIEWED

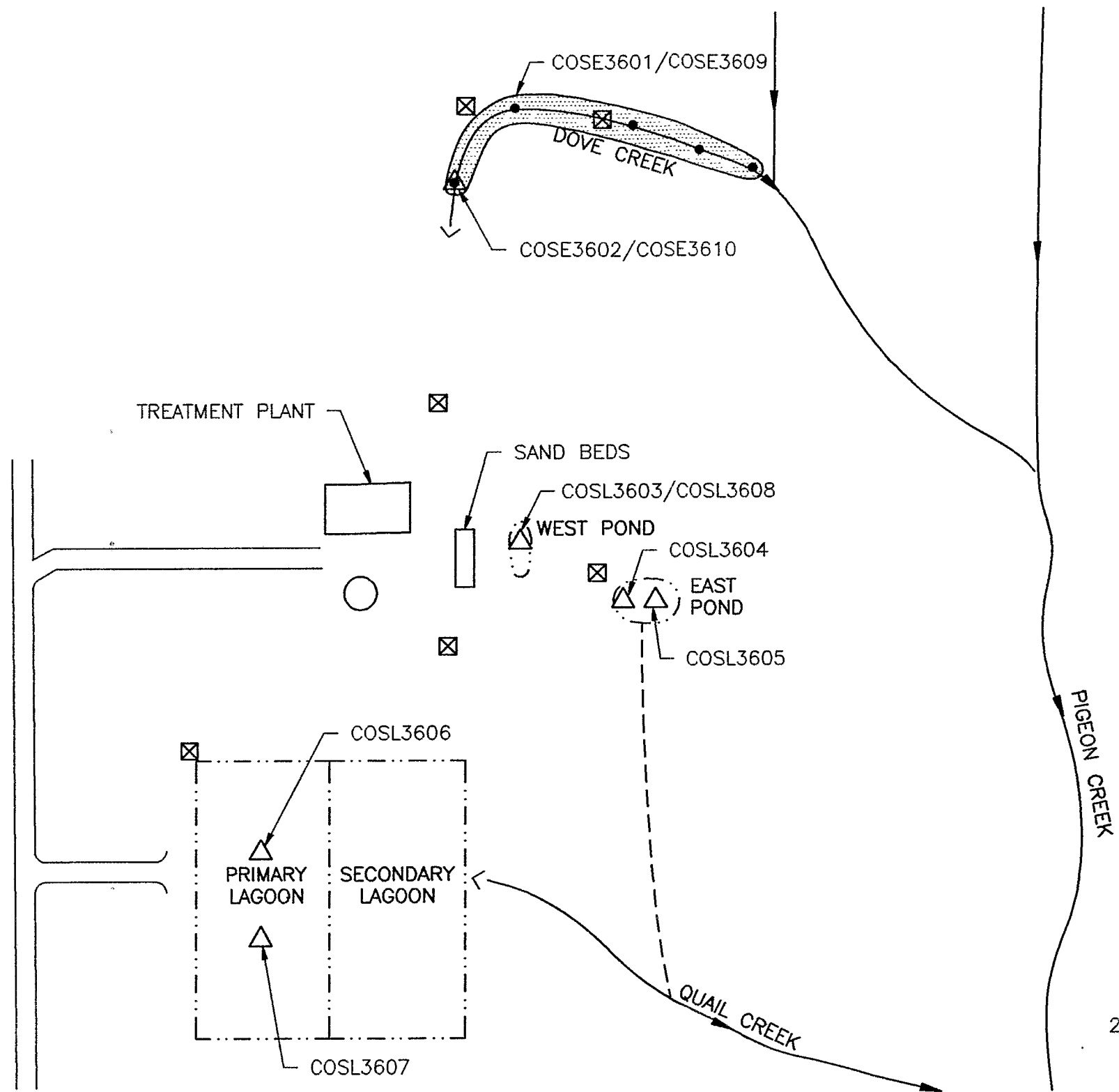
WBB

FILE NAME

8108156

FIGURE NO.

13



LEGEND:

- COSE3602 DISCRETE SAMPLE LOCATION
- COSE3601 GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE GRAB SAMPLES
- BUILDING/STRUCTURE
- ROAD
- WOOD SURVEY STAKE
- DISCHARGE PIPE
- SURFACE FLOW DIRECTION
- FORMER DRAINAGE

NOTES:

1. SAMPLES COSE3609 AND COSE3610 ARE DUPLICATES OF COSE3601 AND COSE3602, RESPECTIVELY.
2. SAMPLE COSL3608 IS A SAMPLE SPLIT OF COSL3603.



Chicago, Illinois

TITLE
SITE 36
PHASE-I SAMPLE LOCATIONS

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

DRAWN

TPK

DATE

12-20-93

JOB NO.

923-8108

CHECKED

RA

SCALE

AS SHOWN

DWG. NO.

REVIEWED

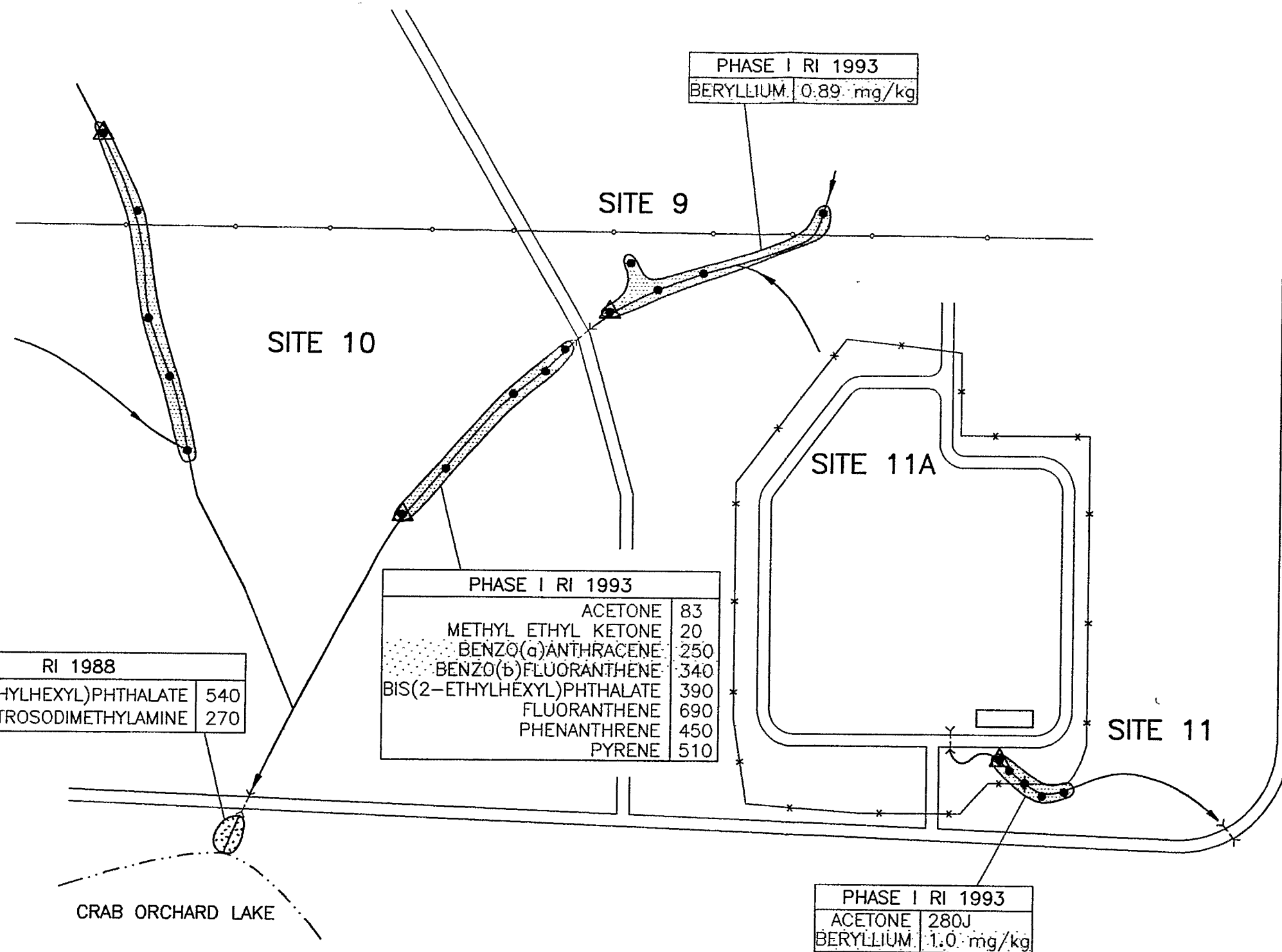
RA

FILE NAME

8108123

FIGURE NO.

14



LEGEND:

- VOC SAMPLE LOCATION
- GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE SUBSAMPLES
- GENERAL AREA OF COMPOSITE SAMPLE COLLECTED BY O'BRIEN AND GERE 1988
- POWER LINE
- FENCE
- BUILDING/STRUCTURE
- ROAD
- CULVERT
- SURFACE FLOW DIRECTION
- ANALYTE CONCENTRATION GREATER THAN THE PLC/APLC

NOTES:

1. CONCENTRATIONS ARE IN $\mu\text{g/kg}$ EXCEPT AS NOTED.
2. J = CONCENTRATION IS ESTIMATED.



Chicago, Illinois

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

TITLE

SITES 9, 10, AND 11 SUMMARY OF ANALYTICAL RESULTS










DRAWN	TPK	DATE	12-21-93	JOB NO.	923-8108
CHECKED	RA	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	RA	FILE NAME	8108146	FIGURE NO.	15

PHASE I RI 1993	
METHYL ETHYL KETONE	14
ACETONE	52

RI 1988	
TOTAL PCBs	900
N-NITROSODIMETHYLAMINE	262

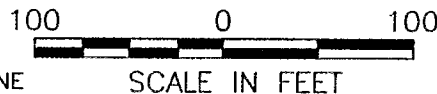
RI 1988	
TOTAL PCBs	300

LEGEND:

-  VOC SAMPLE LOCATION
-  GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE SUBSAMPLES
-  GENERAL AREA OF COMPOSITE SAMPLE COLLECTED BY O'BRIEN AND GERE 1988
-  SURFACE FLOW DIRECTION
-  BUILDING/STRUCTURE
-  CULVERT
-  ROAD
-  FENCE
-  ANALYTE CONCENTRATION GREATER THAN THE PLC/APLC

NOTES:

1. CONCENTRATIONS ARE IN $\mu\text{g/kg}$, EXCEPT AS NOTED.
2. ND = NOT DETECTED ABOVE THE DETECTION LIMIT.
3. NO PLC/APLC DETERMINED FOR 2,4,6,-TRINITROTOLUENE OR HEPTACHLOR EPOXIDE.



PHASE I RI 1993	
HEPTACHLOR EPOXIDE	4.4/ND

PHASE I RI 1993	
METHYL ETHYL KETONE	4
2,4,6-TRINITROTOLUENE	380

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL



Chicago, Illinois

TITLE

SITE 11A
SUMMARY OF
ANALYTICAL RESULTS

DRAWN

TPK

CHECKED

RA

REVIEWED

RA

DATE

12-21-93

SCALE

AS SHOWN

FILE NAME

8108145

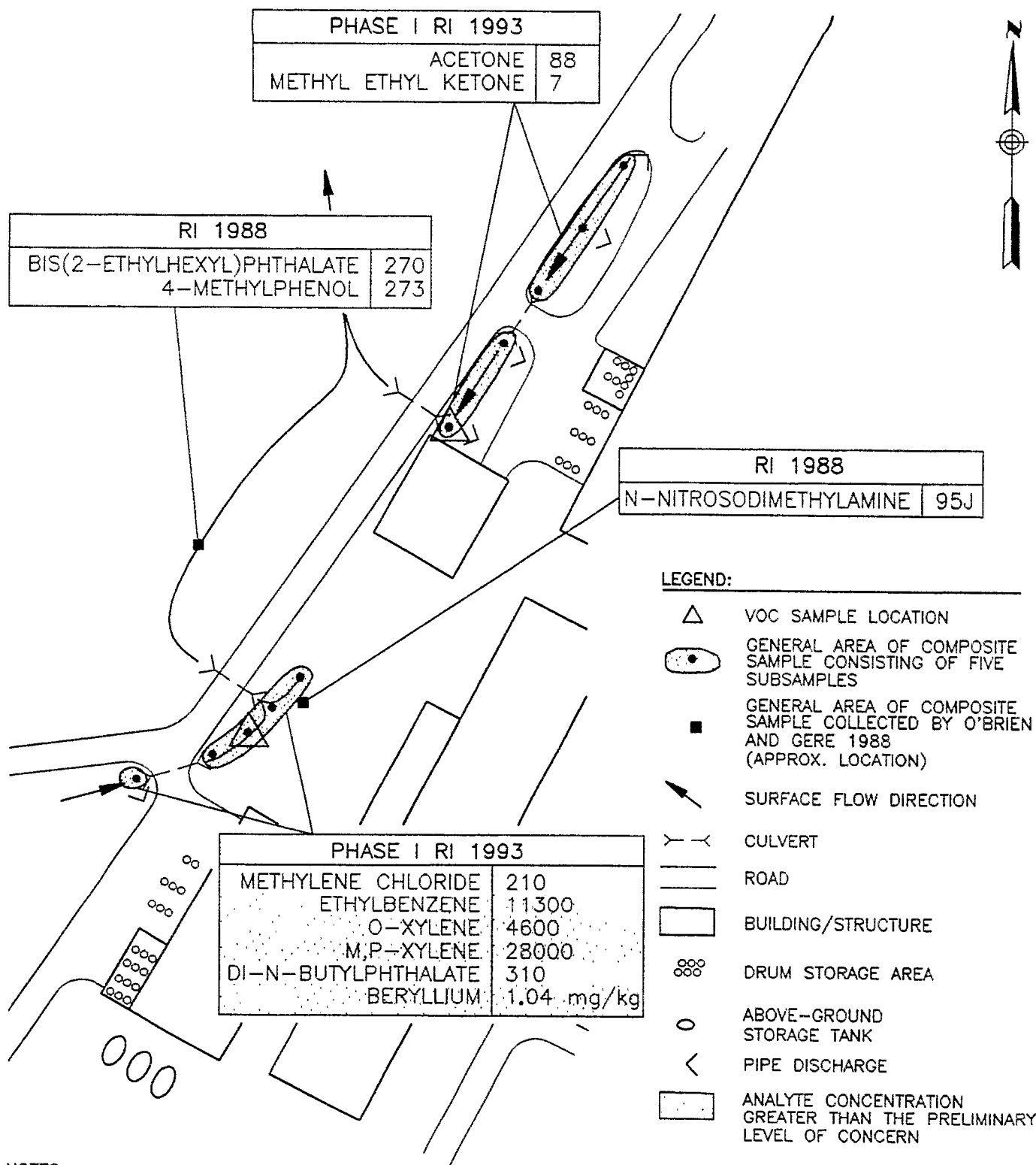
JOB NO.

923-8108

DWG NO.

FIGURE

16



NOTES:

1. CONCENTRATIONS ARE IN $\mu\text{g}/\text{kg}$, EXCEPT WHERE NOTED.

2. J = CONCENTRATION IS ESTIMATED

100 0 100 200 300

SCALE IN FEET



Chicago, Illinois

TITLE

**SITE 14
SUMMARY OF
ANALYTICAL RESULTS**

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

DRAWN

TPK

DATE

12-21-93

JOB NO.

923-8108

CHECKED

KA

SCALE

AS SHOWN

DWG NO.

REVIEWED

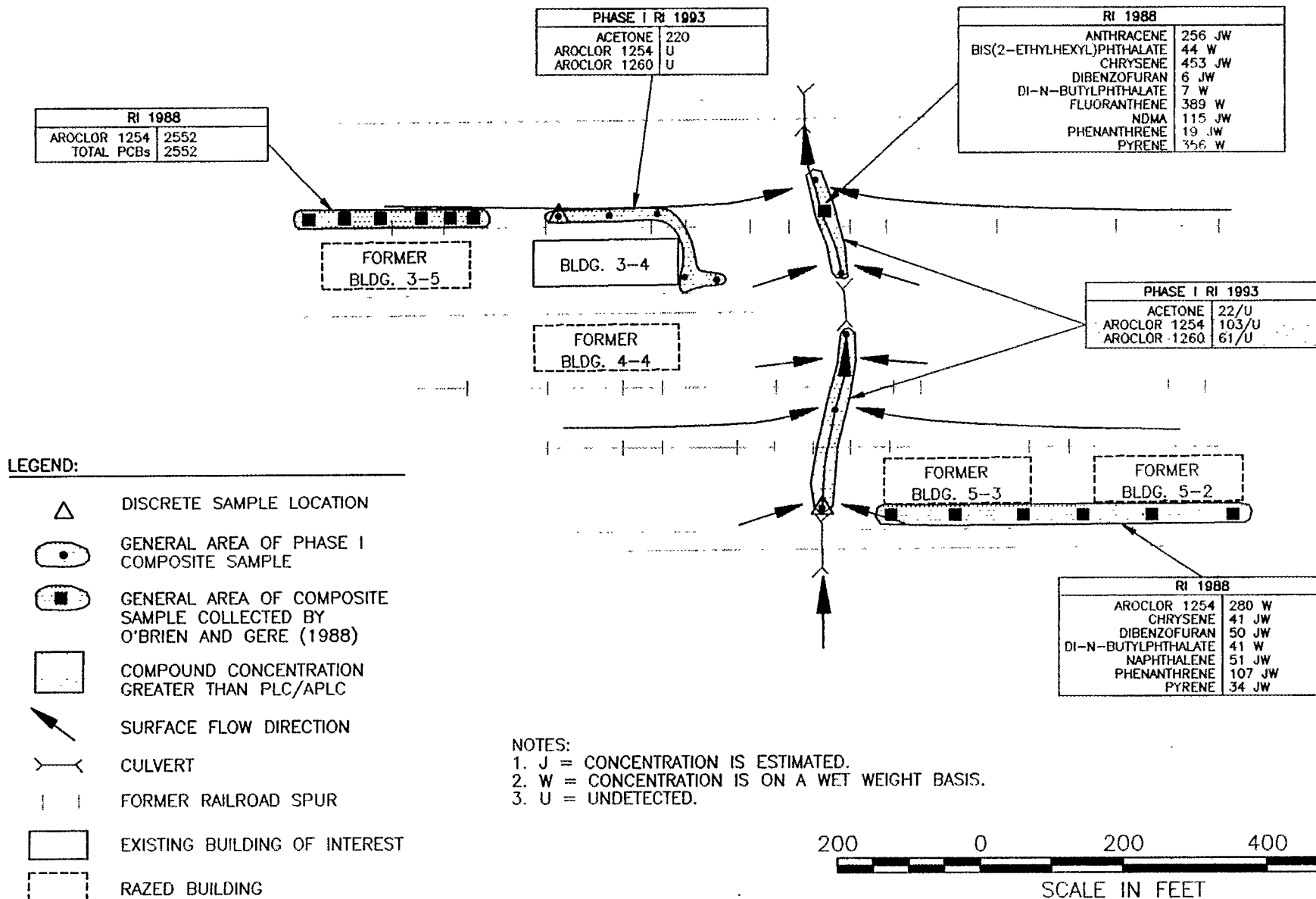
RA

FILE NAME

8108144

FIGURE NO.

17



CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL



Chicago, Illinois

TITLE

SITE 16
SUMMARY OF
ANALYTICAL RESULTS

DRAWN

TPK

CHECKED

RA

REVIEWED

RA

DATE

12-23-93

SCALE

AS SHOWN

FILE NAME

8108153

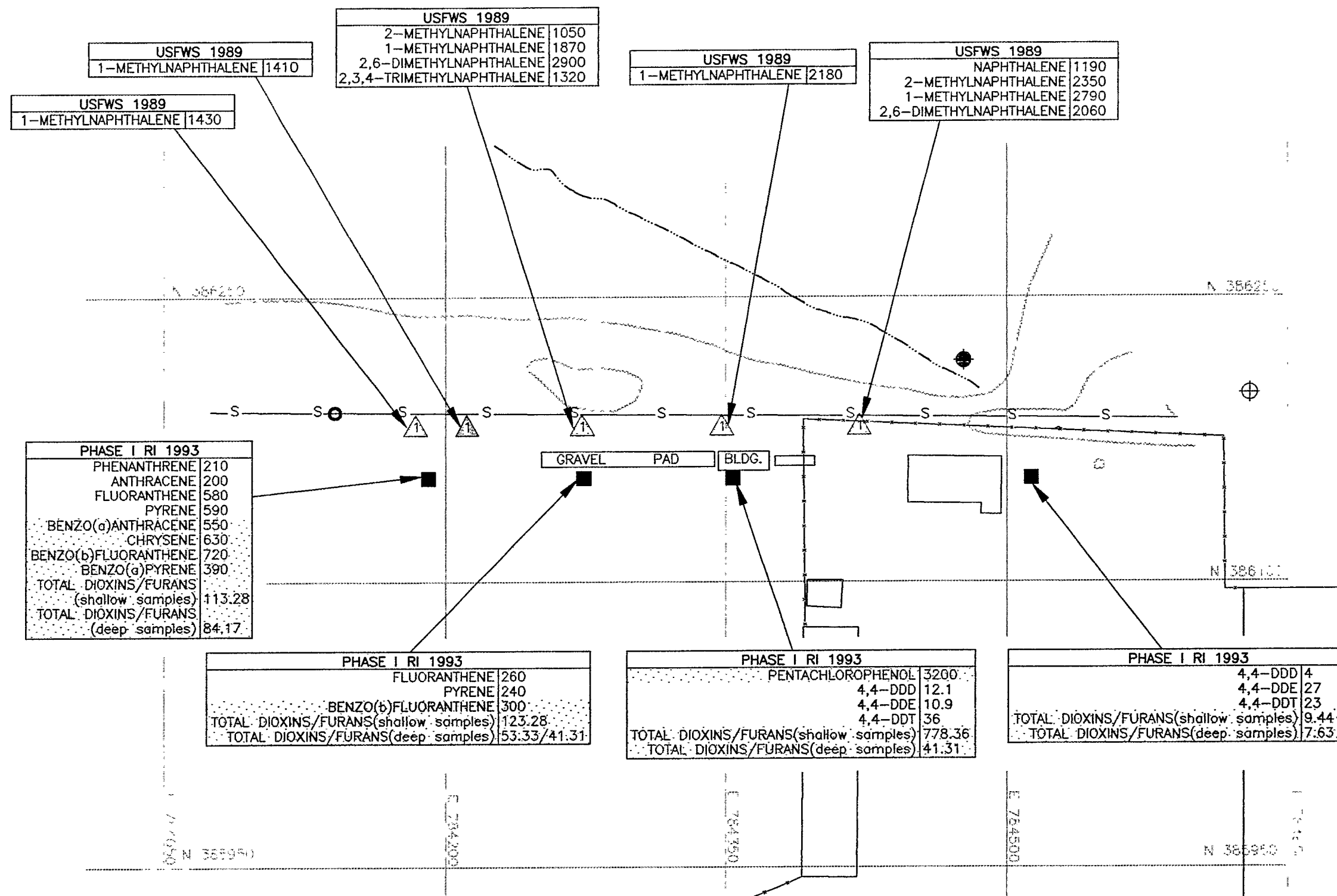
JOB NO.

923-8108

DWG NO

FIGURE

18



LEGEND:

- GENERAL AREA OF COMPOSITE SOIL SAMPLE 1993 PHASE I RI
- △ GENERAL AREA OF SAMPLE COLLECTED BY USFWS 1989 (APPROX. LOCATION)
- MONITORING WELL INSTALLED FOR 1988 RI
- COMPOUND CONCENTRATION GREATER THAN THE PLC/APLC.
- ⊕ GENERAL LOCATION OF RA MONITORING WELL (SITE 22)
- x- FENCE
- BUILDING OR FOUNDATIONS
- S- SANITARY SEWER
- ~ TREE LINE (TYP.)

NOTES:

1. GRID IS IN FEET AND RELATIVE TO ILLINOIS STATE PLANE COORDINATES.
2. CONTOUR ELEVATIONS ARE IN FEET AND RELATIVE TO MEAN SEA LEVEL.
3. CONTOUR INTERVAL IS ONE FOOT.
4. ALL CONCENTRATIONS IN $\mu\text{g}/\text{kg}$, EXCEPT WHERE NOTED.
5. BASE MAP FROM DRAWING CER 61-400E, SHEET REF. NO. C4, DATED FEB., 1993, BY WOODWARD-CLYDE CONSULTANTS.



Chicago, Illinois

CLIENT/PROJECT

MW/CRAB ORCHARD RI/IL

TITLE

POST TREATING FACILITY
(SITE 22A)
SUMMARY OF ANALYTICAL RESULTS

DRAWN	TPK	DATE	12-23-93	JOB NO.	923-8108
CHECKED	RA	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	RA	FILE NAME	8108154	FIGURE NO.	19

PHASE I RI 1993	
ACETONE	93/95
ALDRIN	770/790
AROCLOR-1248	8900/15000
AROCLOR-1254	8200/6800
AROCLOR-1260	950/770
CADMIUM	24/6.5
FLUORANTHENE	ND/120

PHASE I RI 1993	
ACETONE	109

PHASE I RI 1993	
ACETONE	40
AROCLOR-1248	59
AROCLOR-1254	59
CADMIUM	13.0 mg/kg










PHASE I RI 1993	
ACETONE	68
AROCLOR-1248	150
AROCLOR-1254	180
CADMIUM	29 mg/kg

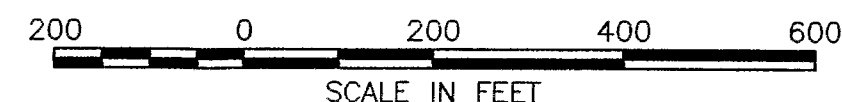
USFWS 1988	
AROCLOR-1254	560

PHASE I RI 1993	
ACETONE	880
METHYL ETHYL KETONE	161
O-XYLENE	61
M,P-XYLENE	58
ALDRIN	1580
AROCLOR-1248	20700
AROCLOR-1254	34000
AROCLOR-1260	4100
ANTIMONY	19.5
CADMIUM	27 mg/kg
LEAD	320 mg/kg
ACENAPHTHALENE	18300
ANTHRACENE	6300
BENZO(a)ANTHRACENE	2700
BENZO(a)PYRENE	900
BENZO(b)FLUORANTHENE	1850
CHRYSENE	1490
DIBENZOFURAN	13200
FLUORANTHENE	14400
FLUORENE	29000
2-METHYLNAPHTHALENE	13600
NAPHTHALENE	5800
PHENANTHRENE	32000
PYRENE	8000

PHASE I RI 1993	
METHYLENE CHLORIDE	800
ALDRIN	3300
AROCLOR-1248	42000
AROCLOR-1254	80000
AROCLOR-1260	7800
ANTIMONY	39 mg/kg
CADMIUM	16.7 mg/kg
LEAD	500 mg/kg
THALLIUM	0.72 mg/kg
ACENAPHTHALENE	28000
ANTHRACENE	9400
BENZO(a)ANTHRACENE	3900
BENZO(a)PYRENE	1440
BENZO(b)FLUORANTHENE	3900
BIS(2-ETHYLHEXYL)PHTHALATE	1220
CHRYSENE	2610
DIBENZOFURAN	19700
FLUORANTHENE	24200
FLUORENE	44000
2-METHYLNAPHTHALENE	18900
NAPHTHALENE	6100
PHENANTHRENE	50000
PYRENE	13900

LEGEND:

-  DISCRETE SAMPLE LOCATION
-  GENERAL AREA OF COMPOSITE SAMPLE CONSISTING OF FIVE SUBSAMPLES
-  GENERAL LOCATION OF SAMPLE COLLECTED BY USFWS
-  BUILDING/STRUCTURE
-  ROAD
-  DISCHARGE PIPE
-  SURFACE FLOW DIRECTION
-  FORMER DRAINAGE
-  COMPOUND CONCENTRATION GREATER THAN THE PLC/APLC



- NOTES:
1. CONCENTRATIONS ARE IN $\mu\text{g/kg}$, EXCEPT AS NOTED.
 2. INFORMATION ON USFWS SAMPLES FROM WADE, (1988).



Chicago, Illinois

CLIENT/PROJECT

MW/Crab Orchard RI/IL

TITLE

SITE 36
SUMMARY OF ANALYTICAL RESULTS

DRAWN	TPK	DATE	12-23-93	JOB NO.	923-8108
CHECKED	RA	SCALE	AS SHOWN	DWG. NO.	
REVIEWED	RA	FILE NAME	8108147	FIGURE NO.	20

APPENDIX A

RESPONSES TO AGENCY COMMENTS ON THE AUGUST 1993
DRAFT REPORT ON THE PHASE-I RI OF THE MISC AOU

A. Response to Comments by USEPA dated October 18, 1993 on Draft Phase I Remedial Investigation Report

Comment 1: A list of the acronyms should be considered in the final report to assist in the readability of the report.

Response 1: A list of acronyms will be prepared and presented in the revised Phase I RI report.

Comment 2: Listing the site names along with the identifier would be beneficial to the reader in all section headings.

Response 2: Site names will be included in all relevant section headings.

Comment 3: Executive Summary, page i. The executive summary indicates that the Phase I RI included 16 sites. Page 1 of the Introduction indicates that 19 sites were evaluated as part of the Phase I RI. It is suggested that the executive summary be revised so that the number of sites evaluated are clearly identified.

Response 3: The difference between 16 sites and 19 sites is the following 3 sites for which no Misc AOU RI activities are required by the FFA: Sites 13, 18 and 34. This will be clarified in the revised Phase-I RI Report.

Comment 4: Section 1.1., page 3, 1st paragraph. The acronym for Fish and Wildlife Service, "FWS" should be spelled out since it has not been previously introduced.

Response 4: The text will be revised accordingly.

Comment 5: Section 1.4, page 4. The site background does not include the date at which the site originally began operating as the Illinois Ordnance Plant.

Response 5: According to USFWS personnel, the Illinois Ordnance Plant began operation in June of 1942. This information will be incorporated into the Revised Phase-I RI Report.

Comment 6: Section 1.6, page 6. A brief summary of the conclusions of the previous site investigations (Ruelle (1983), and Illinois DPH (1987)) is recommenced.

Response 6: The revised submittal will include a brief summary of the investigations and pertinent findings.

Comment 7: Agreed. Sections 1.6.1 and 1.6.2, pages 6 & 7. D Area and P Area should be introduced/identified in Section 1.6 and their significance stated. Since each site within D Area and P Area are also listed individually, we do not see the significance of listing D Area and P Area separately.

Response 7: The following will be added as the last paragraph of Section 1.6: Eleven of the Misc AOU sites (Table 1) are within three designated industrial areas (D Area, P Area and Area 14) that were established when the Refuge facility was operated as the Illinois Ordinance Plant. Site histories are presented below using, where appropriate, the area designations. The remaining sites (Sites 16, 18, 21, 22A, 24, 25, 26, 27, 34, 35 and 36) are then discussed in numerical order.

Comment 8: Section 1.6, pages 6 though 12. The sites listed but not included in the Phase I RI should be so identified. Currently, some sites are identified as not being included in the RI while others are not.

Response 8: Following the paragraph described in response to comment no. 7, the following additional paragraph will be added: Of the 23 sites that are part of Misc AOU, the RI included (as described in the Project Work Plans) preliminary site visits at 3 sites (Sites 21, 27 and 35) and collection and analysis of samples at 12 sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20 and 36). No RI activities were completed or are planned at eight Misc AOU Sites (13, 18, 24, 25, 26, 30, 31 or 34) because of the following: 1) the previous RI used Sites 30 and 31 as control sites, as they are known to be removed from previous and present potential sources of contamination; 2) the previous RI determined that Sites 13, 18, 24, 25 and 26 present no exposure risk to human health or the environment; 3) the Federal Facilities agreement stated that Sites 24, 25 and 26 require no additional work - these sites are outside the Refuge boundary and are not on DOI property; and 4) Site 34 (Crab Orchard Lake) is currently being monitored and/or studied by the Illinois Department of Public Health, Illinois State University and the U.S. Fish and Wildlife Service.

Comment 9: Section 1.6, pages 6 through 12. All sites should be identified as to the type of site it is (i.e., drainage way, drainage channel, etc.). Also, the specific area of concern at each of the sites should be identified (i.e., to store chemicals, manufactured explosives, etc.).

Response 9: The text will be revised to provide the type of site (e.g. Site 7 - Southeast Drainage Channel) and any identified specific areas of concern (e.g. segment of the drainage channel adjacent to the D Area Facilities).

Comment 10: Section 1.6.3, page 8. It is unclear if Diagraph Corporation is still using the site.

Response 10: The revised text will include a statement indicating Diagraph Corporation is currently operating within Area 14.

Comment 11: Section 1.6.7, page 10. Include source of aerial photographs so that they may be used, if necessary, by future users of the report.

Response 11: The appropriate reference (U.S. Department of Agriculture) will be cited in text and the following will be included in the reference section of the report: U.S. Department of Agriculture, 1960. Aerial photos taken May 1, 1960.

Comment 12: Section 1.6.12, page 12. Identify which organizations are continuing to monitor the lake and wildlife populations.

Response 12: The following will be added to the report: According to the USFWS, Crab Orchard Lake is currently being studied and/or monitored by the Illinois Department of Public Health, Southern Illinois University and the Fish and Wildlife Service. Effluent from the waste water treatment plant, which ultimately discharges to the lake, is monitored by the IEPA.

Comment 13: Section 2.2.2.1, page 17. Selection of bulbs for photoionization detector (PID) is inconsistent. Review of Table 3 indicates several different eV bulbs were used on different samples. A rationale for selection should be included.

Response 13: The rationale for bulb selection will be described in the text as follows. The SAP specified the use of a PID equipped with an 11.4 eV lamp for the purposes of conducting headspace screening of grab samples obtained at Sites 11A, 12, 14, 16, and 22A.

The results of this field measurement were used to determine grab sample locations the discrete VOC sample was to be obtained. The first PID for Phase I failed to operate by battery supply. A replacement PID was requested and in the interim, an 11.7 eV PID was made available to the sampling crew by the USEPA oversight. The inoperable PID was replaced by a PID with a 11.8 eV lamp, as an instrument with an 11.4 eV lamp was unavailable. An additional 10.0 eV PID was obtained as backup. It was observed in the field that the 10.0 eV PID was more sensitive to organic vapors than the higher 11.7 and 11.8 eV PIDs. Therefore, it was decided by the field team that both the 10.0 eV lamp and a higher eV lamp (11.7 or 11.8 eV lamp, depending on availability) be used, whenever possible, for headspace screening purposes. The PID substitutions are documented in the Daily Quality Control Reports and the QCSR.

Comment 14: Section 2.2.2.1, page 17. Sampling procedures indicate that "once the sample material had been retrieved, the liner containing the soil sample was removed from the core sample and soil from the sample location was added to the ends of the sample liner, if necessary, to minimize headspace." How was this done and what procedures were followed to ensure that no cross contamination or inadvertent contamination

occurred? Was a plastic liner used (as was the case for the sludge sample) to collect the additional sample volume?

Response 14: A stainless steel liner was used for every sample that was collected using the sampling device. Samples were sent to the laboratory in their sample liner. Typically, no additional material was required to fill void space and seal the ends of the sample liner. Where there was void space, a decontaminated stainless steel spoon and/or spatula was used to retrieve additional material from the sample location and fill the end of the sample liner.

Comment 15: Section 2.2.2.1, page 17. Samples were placed in a cooler and stored in the presence of "wet" ice. What is "wet" ice? Other samples were identified as being placed on ice. Is there a significance for the "wet" ice? Also in Section 2.2.3 - Sample shipment, samples were identified as being preserved during shipment using "regular" ice.

Response 15: "Wet" ice, "regular" ice and ice are synonymous and refer to commercially produced ice available from many retail stores, in contrast to "dry" ice. In the revised text, "ice" will be used.

Comment 16: Section 2.2.2.2, page 18. Specify whether or not the sediment samples were saturated at the time of sample collection and whether or not the liquids were decanted. Include same information for sludge samples.

Response 16: The text will be revised to include a statement that sediment samples were saturated at the time of collection and that no decanting of liquids was undertaken.

Comment 17: Section 2.2.3, page 19. PACE Laboratories has several laboratories throughout the United States. The location of the laboratory(ies) should be cited since quality and capabilities varies between locations.

Response 17: The PACE Laboratory facility located in Minneapolis, Minnesota will be specified in the revised text.

Comment 18: Section 2.4.1, page 20, 2nd sentence. Delete this sentence since ARARs are not defined for the site. Also this creates confusion with other sections of the chapter since selection of methods in comparison to ARARs is not addressed.

Response 18: Your comment will be addressed by deleting the sentence.

Comment 19: Section 3.1, page 22. A short discussion on wind velocity and direction should be included in this section, especially since air is later addressed as a potential pathway of concern.

Response 19: Information obtained from the National Atmospheric and Oceanographic Agency pertaining to wind velocity and direction will be cited.

Comment 20: Section 3.4, page 23. We recommend separating "soils" from "geology" since soil scientists and geologists use different terminologies and methodologies. In addition, separating into two sections would be consistent with most RI reports.

Response 20: A separate subsection will be created to provide clarity.

Comment 21: Section 3.5, page 25. Should the table be identified with a table number and title? If so, then the tables on pages 34, 38 39, 41, 42 and 43 should also be identified.

Response 21: Tables found within the main body of the text will be titled; the tables will not be numbered as they are part of the text and to avoid confusion with the numbered tables presented after the text.

Comment 22: Section 3.6, pages 26 and 27.

- a) First bullet - There is no mention of which areas investigated are summarized in this paragraph. Also please include which stratigraphic unit groundwater is found in (e.g., till, outwash).
- b) Third bullet - There is no mention of which area the paragraph refers to. It is unclear if this is regional or site-specific data.
- c) Fourth bullet - There is no mention of which study area the paragraph refers to. Also "this unit" is not defined.

Response 22: a) In the first bullet, the text will be revised to clarify which areas apply to what information and will identify the stratigraphic unit in which groundwater is found.

- b) The text will be revised to clarify which area the information pertains to.
- c) It will be made clear in the revised text as to which area the information applies and the "unit" will be defined.

Comment 23: Section 3.7, page 27. Mention the source of water for the City of Herrin (e.g., reservoir or groundwater).

Response 23: The City of Herrin obtains its water supply from Rend Lake. This will be stated in the revised text.

Comment 24: Section 4.0, page 29. Cite methods used to validate the data (e.g., EPA National Functional Guidelines).

Response 24: Methods used to validate the data will be cited in the revised report.

Comment 25: Section 5.2.1, page 31. New LUST cleanup objectives will become law on approximately September 13, 1993. Since the 1991 objectives will no longer be applicable, will the new objectives now apply to the BETX and PNA levels for the sites within this RI investigation?

Response 25: The new LUST law (Public Act 88-496) does not have soil cleanup objectives and, therefore, it is not necessary to modify the PLC levels.

Also, please understand that the report does not intend to imply that the Misc AOU sites are subject to the LUST regulations or that releases of BTEX or PNAs must be remediated in a manner consistent with the LUST cleanup objectives. The LUST cleanup objectives were used as PLCs for general screening purposes only and because they are readily available and conservative. The LUST requirements would, indeed, be pertinent if they become ARARs.

Comment 26: Section 5.2.1, page 32. PLC for VOCs cannot be NOAEL values because NOAEL values are doses and not concentrations.

Response 26: NOAEL values will not be considered candidate PLCs; reference to the NOAEL values will be removed from the PLC discussion.

Comment 27: Section 5.2.1, page 32. Why were ambient water quality criteria used to determine soil criteria? Could be estimated by using partitioning coefficients, but cannot be applied directly.

Response 27: Ambient Water Quality Standards (AWQS) were considered as candidate PLCs because sediments were sampled that are in direct contact with aquatic wildlife. These values will be overly conservative; therefore, their reference will be stricken from the report.

Comment 28: Section 5.2.1, page 32. It needs to be recognized that the residential exposure scenario approach only factors in direct contact with the media and for many compounds (e.g., VOCs and SVOCs) the much more important route is the migration to groundwater pathway. Therefore, this approach will grossly underestimate the potential risk levels at the site and will not present an appropriate screening for the levels of concern.

Response 28: In the Phase-I RI Report, the residential exposure scenario is not being used to evaluate risk levels but to provide candidate PLC values for soils/sediments - the sampled media. PLCs are essentially vehicles to determine which sites will need additional remedial activities. Of the three

exposure scenarios (residential, recreational and industrial), the residential exposure scenario results in the most conservative values and was, thus, the most appropriate to use.

At sites where the compounds of concern have a propensity to partition into the groundwater, Phase II groundwater investigations will be planned. If during the RI it is determined that groundwater has been impacted at a particular site, groundwater at that site will be assessed relative to appropriate criterion (e.g. MCLs) and groundwater exposure scenarios will be evaluated in the risk assessment.

Comment 29: Section 5.2, page 34, Table. The detection limit for acetone should be 21 not 210 ug/kg. All sample concentrations on the table are not from the reference sample (COSE1002). Please check all tables for sample reference adequacy.

Response 29: The table will be revised to indicate that the correct results are for analysis of sample COSE1001 (SVOCs, pesticides and PCBs, explosives and TAL) and sample COSE1002 (VOCs).

Comment 30: Section 6.1, page 45. Section 6.1 indicates that sites where PLCs are exceeded for only TAL metals, which have been identified by background data to occur naturally in soils and are not considered to be of concern, and are not being addressed. This is somewhat of a contradiction and should be clarified. In addition, we question the validity that TAL metals above PLCs and background levels should be eliminated before a contaminant fate and transport is completed for these compounds.

Response 30: PLCs in the Draft RI Report are based on the 95% upper confidence level of the background samples (mean plus two times the standard deviation). We could have based the PLC level on the upper limit of the background range but we feel the 95% upper confidence levels is more conservative and appropriate for PLCs.

In regards to the last questions of the comment; parameters that were detected are being evaluated for the potential risk to the local ecology as part of the Preliminary Ecological Assessment. A site that fails the conservative PLC screening or is identified as a potential risk in the Preliminary Ecological Assessment will be considered for inclusion in future remedial investigations.

Comment 31: Section 6.2, page 47, last paragraph. Please add a statement on the discharge of contaminated groundwater to surface water.

Response 31: Adding a statement on the discharge of contaminated groundwater is not appropriate in the Phase-I Report because the potential pathways are established based on the results of previous and Phase I results and groundwater has not been sampled and analyzed at any of the sites

included in the Phase-I RI. If the results of Phase-II groundwater sample analysis indicate that groundwater has been adversely impacted, discharge of contaminated groundwater will be considered a pathway.

Comment 32: Section 6.4.1, page 51, last paragraph. Incorporate depth to groundwater in the discussion since hydrogeology for this area was previously investigated.

Response 32: Investigations completed at Site 17 (located approximately one mile northwest) and at the COC area (located approximately 1½ miles southwest) are the nearest groundwater investigations to Site 10. The information from these investigations is not specific to Site 10 and to include it would make the contents of the discussion of each site in the report inconsistent. We suggest that the results of nearby groundwater investigations be presented in the Phase II work plans for sites where Phase II investigations are planned.

Comment 33: Section 7.0 General Comment. The term "several" is used to describe resampling recommendations. The number of samples should be defined if appropriate for the scope of the project.

Response 33: Phase II remedial investigative activities, including specific sampling recommendations, will be described in Phase II RI Work Plans.

Comment 34: Section 7.2.1, page 56. Recommendation is to collect upstream samples and analyze for TCL SVOCs. Include discussion of upstream samples collected at area 9 which were analyzed for TCL SVOCs and is upstream of this area.

Response 34: The revised text will include in the Site 10 section (Section 6.4.1 and/or Section 7.2.1) a discussion on the relevance of the SVOC results of the Site 9 sample.

Comment 35: Table 12, page 4 of 5. The Aldrin detect in samples COSE3601 and COSE3609 is below the method detection limit. We recommend that this data be "J" coded.

Response 35: Table 12 and Section 5.2.14.1 will be revised accordingly.

Comment 36: Throughout the document, the report refers to analyzing various samples for Target Compounds List (TCL) and Target Analyte List (TAL) inorganic parameters. The TAL does not include cyanide. The statements relating to the analytical program should therefore be revised appropriately to state that the samples are analyzed for TCL, TAL and cyanide.

Response 36: USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis (document numbers ILM 01.0 and ILM 03.0) do include cyanide in the Inorganic Target Analyte List (TAL) (Table C-1).

Comment 37: In accordance with the procedures in the USEPA Functional Guidelines, data should be qualified as undetected for sample results either less than 10 times the value of the common laboratory contaminants (methylene chloride, acetone, 2-butanone, and toluene) detected in the associated blank sample or less than 5 times the value detected in the associated blank sample for any other contaminating compound. Please make these revisions to the last paragraph of Section 4.0 (page 29).

Response 37: In the revised report, the following sentence will replace the last sentence of the last paragraph of Section 4.0: The data was qualified as not detected ("U") if the analytical results were either less than 10 times the value of the common laboratory contaminants (see the attached QCSR for the laboratory contaminants) detected in the associated blank sample or less than 5 times the value detected in the associated blank sample for any other contaminating compound.

Comment 38: When the measured concentration of the sample is less than the instrument detection limit (IDL), it should be reported as not detected. When the measured concentration of the sample is above the IDL but less than the method detection limit (MDL), the result should be estimated and the value qualified with a "J". Please make these revisions to the last paragraph of Section 4.0 (page 29).

Response 38: The revised submittal will replace the second sentence of the last paragraph on page 29 with the following: When the measured concentration of the sample is below the instrument detection limit (IDL), it is reported as not detected ("ND"). When the measured concentration of the sample is above the IDL, but lower than the method detection limit (MDL), the concentration is estimated and qualified with a "J".

::

B. Response to Comments by USEPA dated October 18, 1993 on Preliminary Ecological Risk Assessment

GENERAL COMMENTS

Comment 1: The report often refers to bioaccumulation potential of various contaminants. Bioaccumulation potential alone is not adequate to describe the ecotoxicology of contaminants. In addition, it can be mistaken for various other ecotoxicological properties of a contaminant, such as biomagnification. Finally, BCFs are generally not accurate for predicting contaminant accumulation by aquatic organisms, and BCFs do not address contaminant uptake by terrestrial organisms. For these reasons, provide the definition of BCF and discuss its usefulness and implications for ecological risk assessment.

Response 1: Bioaccumulation potential has not been used at any stage of this study to describe ecotoxicology effects of contaminants on receptor organisms. Rather, we have used bioaccumulation to assist in quantifying exposure concentrations for food pathways for terrestrial predators. Specific references to toxicological responses are based on information reported in the literature, e.g., the most sensitive dosage value reported from dose-response tests were selected as an indicator of the ecotoxicological response of terrestrial animals to contaminants (see Section 4.0 for details).

Terminology with respect to bioaccumulation and bioconcentration is inconsistent in the scientific literature. For example, Sutek (1993) defines bioconcentration as "the net accumulation of a chemical directly from an aqueous solution by an aquatic organisms" and bioaccumulation as "net accumulation by an organism as a result of uptake from all routes of exposure. Others do not restrict bioconcentration to aquatic organisms, e.g., Travis and Arms (1988) define the bioconcentration factor (BCF) as the chemicals concentration in the organism or tissue divided by its concentration in water (aquatic organisms), food (terrestrial animals), or soil (terrestrial plants). This latter definition of BCF is the one used in the U.S. EPA's Superfund Exposure Assessment Manual and is the one followed in this preliminary risk assessment.

The use of published BCFs to estimate exposure concentrations for aquatic animals and terrestrial plants is a method suggested by the U.S. EPA (1988) where there are insufficient data to develop site-specific BCFs. There is of course uncertainty associated with the use of published BCFs, as they vary depending upon contaminants, site conditions and species. For this reason, the highest BCF recorded in the literature was used in this study. In cases where bioaccumulation is a potentially important pathway, the BCF values need to be confirmed with site-specific data, as is recommended in the preliminary risk assessment.

The discussion of the use of BCFs has been expanded and clarified in the final report (Section 3.3.1).

Comment 2: Preliminary Levels of concern (PLCs) - On page 31 of the Phase I Remedial Investigation Report, where PLCs are defined, the following should be clarified: "biological impact exposure levels." Apparently for cadmium and lead, these levels are taken from a previous Record of Decision. The ecological benchmark level for cadmium levels in sediment could be as low as 0.6 mg/kg using the "Lowest Effect Level" of the Ontario Sediment guidelines as a benchmark (their "Severe Effect Level" is 10 mg/kg). In light of the above, the ecological assessment should not state that very conservative PLCs were used to select contaminants of concern. Generally, contaminants of concern are determined separately from those of human health. The report must incorporate more conservative ecological benchmarks.

Response 2: As suggested, specific PLCs have been developed specifically for this preliminary ecological risk assessment. These PLCs are based on minimum value from the following criteria:

- CCME (1991): Interim Canadian Environmental Quality Criteria for Contaminated Sites;
- Ontario Environment (1992): Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.
- IEPA (1991): Leaking Underground Storage Tank Manual;
- NOAA (1991): Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program.

In cases where the minimum value is lower than background levels or where there are no published criteria, the PLC was set to equal the upper 95 % confidence interval value computed from background samples.

Several of these new PLCs are more conservative than the previous ones; consequently, risk calculations were required for more sites and constituents.

SPECIFIC COMMENTS

Comment 1: Page 4, Section 2.0

It is stated that the USFWS was contacted for information regarding special and sensitive ecological resources in the area. Was the State Natural Heritage database also consulted? If not, it should be reviewed since the State often has more regionally specific information than the USFWS.

Response 1: Incorporated suggestions into the revised report.

Comment 2: Page 5, Section 2.1

A brief description of the site geology should be included as another section under heading (2.1).

Response 2: Incorporated suggestions into the revised report.

Comment 3: Page 5, Section 2.1.3

Please estimate the percentage of each habitat type occurring on the Refuge.

Response 3: Incorporated suggestions into the revised report.

Comment 4: Page 6, Section 2.1.3.1

Under "Deciduous Forest", the fourth sentence states that "these mature stands are generally intolerant species." Please specify the species referred to under mature stands and to what these species are intolerant of (i.e., wet soils, shade, etc.). Also, specify the species of oaks that are present in the bottomland communities.

Response 4: Incorporated suggestions into the revised report.

Comment 5: Page 7, Section 2.1.3.3

Please estimate size (acreage) and depth of Crab Orchard Lake. Also estimate the drainage area of the lake, and the types of drainage (i.e., agricultural, deciduous forest, etc.) and percent contribution of each drainage type.

Response 5: Incorporated suggestions into the revised report.

Comment 6: Page 8, Section 2.1.4

It would be helpful to describe the specific reasons for concluding that none of the study sites warranted concern for the endangered or threatened species listed. Such a conclusion seems more likely to be appropriate only after ecological risk from contaminants has been addressed. Also, what about flora? Are any flora species listed for the area and were any studies conducted for them? List reasons why studies were not conducted if they occur at the site and were not separately considered.

Response 6: Incorporated suggestions into the revised report.

Comment 7: Page 8, Section 2.2

Please define how many sites and community types were evaluated.

Response 7: Incorporated suggestions into the revised report.

Comment 8: Page 9, Section 2.2.1

Describe the width of the intermittent stream and likelihood/evidence of flooding, how far it is to the stream's headwaters and what other habitats the stream passes through before entering Olin property. Also state if any aquatic flora were noted growing in or along the stream, and species observed. Is any water quality or microinvertebrate data available for the stream? A microinvertebrate study should be conducted since certain species are more pollution sensitive than others and would give a better indication as to whether or not the stream is potentially contaminated. Also, the upland habitats described in paragraph 4 of the first sentence do not correspond to those listed under Section 2.1.3. Is it old field or industrial? List in a table, by site, vegetation species occurring/expected to occur in each habitat type. Separate the species according to woody, grasses, ferns, and wildflowers.

Response 8: Incorporated information on stream characteristics into revised report.

No water quality or invertebrate data are available for the stream. Given the intermittent nature of the stream, its small size, and soft bottom, "pollutant-sensitive" species would not inhabit this stream even if there were no anthropogenic impacts. (Indeed, observations made during the field reconnaissance noted the presence of "pollutant-sensitive" species such may chironomids at this site). Thus, the lack of "pollutant-sensitive" species (e.g., stoneflies, mayflies) may reflect physical habitat rather than the presence of contaminants, and benthic invertebrate studies that focus on community structure would not be useful for assessing whether or not the stream is contaminated.

Comment 9: Page 10, Section 2.2.1

Describe how the bird observations were done, i.e., early morning stations along a transect, incidental observations, etc. State how the season of observation may have affected the number and/or type of species observed. List (in a table) bird species observed for each site and those that are expected to occur at each site (and the season) but were not observed (i.e., other likely receptors). Also, describe what factors were used to determine the common mammal and herpetofauna species listed for each site. The following mammals are also likely to frequent these sites: raccoon, red fox, and opossum.

Response 9: As this is a preliminary investigation, detailed field studies were not carried out at each site so detailed species lists for each site would be meaningless. Instead, we have compiled (in Appendix I) a list of common animals and plants expected to occur in each habitat type (Section 2.2).

Comment 10: Page 11, Section 2.2.2, paragraph 1

State width and likelihood or any evidence of flooding of the stream. Estimate the drainage area and habitats for each ditch/stream. Describe the species growing along the banks and if any were observed growing in the stream itself. Conduct microinvertebrate sampling to determine if pollution sensitive species occur in the stream.

Response 10: Site 7A includes no permanent aquatic habitats. The only intermittent water body is a ditch that drains into a small intermittent stream following precipitation. Given the intermittent nature of the ditch and stream, their small sizes, low flows and soft bottoms, pollutant-sensitive species would not inhabit these features. Indeed, observations made during the field reconnaissance noted the presence of pollutant-tolerant benthic invertebrate species such as chironomids at this site. Thus, the lack of "pollution-sensitive" species (e.g., stoneflies, mayflies) may simply reflect physical habitat rather than the presence of contaminants and, benthic invertebrate studies that focus on community structure would not be useful for assessing whether or not the stream is contaminated.

As this is a preliminary study, we do not feel that additional time and expense is warranted in defining drainage areas for these small streams. Delineation of these areas would require examination of air photos coupled with a field investigation and would not provide any additional useful information for this level of environmental assessment.

Comment 11: Page 11, Section 2.2.2, paragraph 2

State habitat type, i.e., old field, industrial, etc. Could the low areas be considered wetlands? If so, wetlands might be considered separately as a sensitive habitat. Also, list the species of oaks, hickories and pines observed.

Response 11: The low areas at site 7A are small, ephemeral and probably the result of excavation during the building of the industrial facility. Hence, we feel they should not be considered separately as sensitive habitat.

Comment 12: Page 11, Section 2.2.2, paragraph 3

Same comment as #9.

Response 12: See response to Comment #9.

Comment 13: Page 12, Section 2.2.3

Estimate the drainage area, likelihood and/or evidence of flooding and habitat types for the perennial stream. Conduct microinvertebrate sampling to determine if pollution sensitive species occur in the stream.

Response 13: See response to comments #8 and #10.

Comment 14: Page 13, Section 2.2.3, paragraph 1

Same comment as #9.

Response 14: See response to comment #9.

Comment 15: Page 13, Section 2.2.4

We suggest that the writer estimate the drainage area, likelihood and/or evidence of flooding for the stream, and conduct a microinvertebrate study to determine if pollution sensitive species occur in the stream.

Response 15: See response to comments #8 and #10.

Comment 16: Page 13, Section 2.2.4

Please indicate what facility operations occur at Area P.

Response 16: Incorporated suggestions into the revised report.

Comment 17: Page 14, Section 2.2.4, paragraph 4

Same comment as #9.

Response 17: See response to comment #9.

Comment 18: Page 15, Section 2.2.5

Please note the location of the beaver pond on Figure 4.

Response 18: Incorporated suggestions into the revised report.

Comment 19: Page 15, Section 2.2.5

Same comments as #9 and #15. Also it would be helpful to list the flora species observed along the streambed.

Response 19: See response to comment #9 and #15.

Comment 20: Page 16, Section 2.2.6

Same comments as #9 and #15.

Response 20: See response to comment #9 and #15.

Comment 21: Page 17, Section 2.2.6, paragraph 1

Please list the species of oaks, maples and hickories observed.

Response 21: Incorporated suggestions into the revised report.

Comment 22: Page 17, Section 2.2.7

Same comments as #9, #15 and #20.

Response 22: See response to comment #9 and #15.

Comment 23: Page 18, Section 2.2.8

Please indicate what facility operations occur at Area 14. Describe, if known, what was stored in the above ground tank.

Response 23: Incorporated suggestions into the revised report.

Comment 24: Page 19, Section 2.2.8, paragraph 1

Could the low areas be considered wetlands? If so, they should be evaluated separately as a potentially sensitive habitat.

Response 24: The low areas contained hydrophytes; hence, they fall under the traditional ecological definition of a wetland (i.e., areas with hydric soils, hydrophyte and/or periodic inundation). However, these low areas were created by a man-made impoundment. Hence, if anything, the low areas containing Carex spp. and Cyperus spp. are the result of the man-made impoundment and should not be classified as natural wetlands or sensitive habitats.

Comment 25: Page 19, Section 2.2.8

Same comment as #9.

Response 25: See response to comment #9.

Comment 26: Page 20, Section 2.2.9

Same comment as #24.

Response 26: As with site 12, site 13 was altered by human activities. The area had been disturbed by previous excavation, building and subsequent demolition. The low area was likely the result of these activities and the heavy clay soils, and should not be classified as a natural wetland or sensitive habitat.

Comment 27: Page 21, Section 2.2.9, paragraph 3

Same comment at #9.

Response 27: See response to comment #9.

Comment 28: Page 21, Section 2.2.10

Please estimate the drainage area and the likelihood/evidence of flooding of the drainage system. Also, it would be helpful to list, if known, the chemicals stored by Diagraph Corporation.

Response 28: No stream is located on this site. Chemicals are listed in Section 2.2.10.

Comment 29: Page 22, Section 2.2.10, paragraph 2

Was a sample taken of the black anoxic sediments to determine the nature of the contamination? We suggest a microinvertebrate study of the stream to determine the present/absence of pollution sensitive species. Also, please state the source of the suspected contamination and whether or not the source has been eliminated (i.e., a prior spill/release). Describe the vegetation species growing along the stream banks and compare the vegetation and species observed in and along the contaminated drainage ditch to the other drainage ditches evaluated at this site. Does it support the claim that there are no ecological impacts from the observed contamination?

Response 29: The field reconnaissance study for the preliminary ecological risk assessment was conducted after all samples had been collected, so no sample was taken of the black, anoxic sediments. The solvent/hydrocarbon smell and presence of other volatiles recorded at the site suggest that the potentially impacted sediments may be related to storage and/or manufacturing processes at that site. Phase-II investigations will evaluate these sediments.

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Comment 30: Page 22, Section 2.2.10, Last paragraph

Same comment as #9.

Response 30: See response to comment #9.

Comment 31: Page 23, Section 2.2.11

Describe the industrial operations. Estimate the drainage area and likelihood and/or evidence of flooding of the stream. Describe the headwaters of the stream and what habitats the stream passes through before reaching the industrial park.

Response 31: Incorporated description of industrial operations and stream characteristics into the revised report. See response to comment 10 for drainage areas.

Comment 32: Page 23, Section 2.2.11, Last paragraph

Same comment as #20. Also, please describe the streambank vegetation. A microinvertebrate study to determine the presents/absence of pollution sensitive species is also suggested.

Response 32: See response to comment #9 and #15.

Comment 33: Page 24, Section 2.2.11, paragraph 2

Same comment as #9.

Response 33: See response to comment #9.

Comment 34: Page 24, Section 2.2.11, paragraph 5

If there is a wetland on site, it should be considered separately as a sensitive habitat.

Response 34: There are no wetlands on the site.

Comment 35: Page 24, Section 2.2.12

Please estimate the drainage area and likelihood and/or evidence of flooding of the drainage ditches.

Response 35: See response to comment #10, paragraph 2.

Comment 36: Page 25, Section 2.2.12, paragraph 2

Please indicate the number of drainage ditches comprising the system and how many of these were actually observed. We suggest a microinvertebrate study to determine the presents/absence of pollution sensitive species.

Response 36: See response to comment #10,

Comment 37: Page 25, Section 2.2.12, paragraph 3

Please be more specific as to the exact species for oaks, elms, grasses and legumes.

Response 37: Incorporated suggestions into the revised report.

Comment 38: Page 25, Section 2.2.12, paragraph 4

Same comment as #9.

Response 38: See response to comment #9.

Comment 39: Page 26, Section 2.2.13

Please estimate the drainage area and the likelihood and/or evidence of flooding of the drainage. State, if known, what chemicals were dumped at the site and what, if anything, is contaminated in the drums presently stored on the site.

Response 39: See response to comment #10.

Comment 40: Page 26, Section 2.2.13, Last paragraph

Please state the distance and width evaluated along each drainage system. We suggest this for all sites that have a drainage ditch or stream. List the species of oaks near the rubble pile. List the materials observed in the rubble pile.

Response 40: As this is a preliminary assessment, we did not measure distances and widths of the drainage systems.

Comment 41: Page 27, Section 2.2.13, paragraph 1

Same comment as #9.

Response 41: See response to comment #9.

Comment 42: Page 28, Section 2.2.14

Please estimate the drainage area and the likelihood and/or evidence of flooding of the stream channel. Describe the Pigeon Creek moist soil waterfowl impoundments in terms of number, size, depth and distance from the site and Crab Orchard Lake.

Response 42: See response to comment #10, paragraph 2. Incorporated information on Pigeon Creek moist soils units into the revised report.

Comment 43: Page 29, Section 2.2.15, paragraph 1

Please give specific species of oaks, hickories and grasses observed.

Response 43: Incorporated suggestions into the revised report.

Comment 44: Page 29, Section 2.2.15, paragraph 2

Same comment as #9.

Response 44: See response to comment #9.

Comment 45: Page 29, Section 2.2.15, paragraph 5

Was a sample collected of the soil from the unvegetated areas? If not, please explain why.

Response 45: See response to comment #29.

Comment 46: Page 31, Section 2.2.18, paragraph 4

"No aquatic organisms were observed in the upper reaches of the creek." Please explain the reason for the lack of organisms observed, i.e., whether it is from site contamination, chlorination, etc. Also, describe the headwaters, drainages and estimate the drainage area for Dove Creek.

Response 46: Incorporated suggestions into the revised report.

Comment 47: Page 32, Section 2.2.18, paragraph 2

Same comment as #9.

Response 47: See response to comment #9.

Comment 48: Page 33, Section 2.3

Although beryllium was detected at concentrations only slightly above the PLC, beryllium was detected at several sites above the PLC and therefore should be included as a constituent of concern for Sites 7, 8, 9, and 11 because of the number of times it was detected above the PLC.

Response 48: The revised PLC for beryllium is 4 mg/kg, (see response to general comment #2) and all values are well below the PLC.

Comment 49: Page 35, Section 2.3.6

Since the arsenic level exceeded the PLC by more than 25 percent, arsenic should be included as a constituent of concern for this site.

Response 49: Arsenic exceeded the revised PLC and was included in the revised report as a constituent of concern for this site.

Comment 50: Page 36, Section 2.3.10

BTEX should also include toluene.

Response 50: Incorporated suggestions into the revised report.

Comment 51: Page 37, Section 2.3.11

On page 24, an oily sheen was observed on water at Site 16. Was a sample collected from this area? If not, sampling should be conducted to determine the nature of the observed contamination.

Response 51: The field reconnaissance study was conducted after all samples had been collected, so no sample was collected from the water where sheen was noted.

Comment 52: Page 39, Section 2.3.18, paragraph 3

Fugitive dust emissions and volatilization are potential transport mechanisms due to periodic flooding and resultant sediment deposition on the adjacent streambanks of Dove Creek. These transport mechanisms must also be considered for any other constituents of concern detected in streambeds that are subject to periodic flooding.

Response 52: The streambanks of Dove Creek are grassed and/or forested and fugitive dust emissions from the site would be negligible relative to transport by water. Exposure via volatilization is a more probable pathway than fugitive dust emissions for the volatile organics detected at the site. Exposure from this pathway has been added.

Comment 53: Page 41, Section 2.3.18, paragraph 1

Since the data for pH, redox, temperature, hardness, etc. is not available, it would be helpful to describe the changes the metal will undergo based on increasing/decreasing pH, redox, temperature, etc.

Response 53: Discussion of metals expanded in the revised report.

Comment 54: Paragraph 3

If the lagoons overflow following heavy rainfalls, transport by fugitive dust emissions and volatilization is possible due to sediment deposition.

Response 54: See response to comment 52.

Comment 55: Page 42, Section 2.4, paragraph 1

Was a sample collected from the bare areas of Site 22A? If not, state why?

Response 55: See response to comment #29.

Comment 56: Paragraph 5

Please discuss why the observations noted in 1988 are not consistent with the observations made in July 1993.

Response 56: Incorporated suggestions into the revised report.

Comment 57: Page 43, Section 3.1

We suggest including Sites 7, 8, 9 and 11 for additional analysis based on beryllium and arsenic levels. We also suggest including inhalation pathways for terrestrial biota for sites along streams and ponds that are subject to periodic flooding.

Response 57: A number of additional sites and constituents have been added (see final report). Inhalation pathway was added to sites where volatile organics were detected.

Comment 58: Page 44, Section 3.1.3

Please indicate what VOCs were detected.

Response 58: Incorporated suggestions into the revised report.

Comment 59: Page 47, Section 3.2.2

How were the terrestrial target species selected? Numerous mammals and herpetofauna were listed as potentially occurring at each site. At least one species from each ecological guild and/or niche, and preferably all vertebrate species known to occur at the site, should be evaluated since

chemical toxicities vary widely from species to species. At a minimum, include coyote or fox, beaver, eastern cottontail rabbit, eastern mole or least shrew, deer mouse, fox squirrel or gray squirrel, one species of snake, lizard or turtle. The effect on the smaller animals and burrowing animals is likely to be greater due to smaller home ranges and preening and grooming behaviors (for burrowing animals).

Response 59: The suggestion of selecting one species from each ecological niche or all vertebrate species known to occur at the site is not practical given the scope of a preliminary screening for an ecological assessment. Indeed, the USEPA Region V Regional Guidance for Conducting Ecological Assessments states, "The preliminary screening report should be concise, with an emphasis on a simple yet meaningful approach. It is not intended to be a full, detailed predictive ecological risk assessment." Moreover, although chemical toxicities may vary widely from species to species (as noted by the U.S. EPA reviewer), there is little published data on wildlife species' toxicities to the various site contaminants. Therefore, our approach was to select dominant herbivores and carnivores for each site as our species of concern and use conservative safety factors when extrapolating critical toxicity values from the literature. After considering all relevant exposure routes, including exposure to bioaccumulating contaminants through consumption of food, water, or incidental consumption of soil and sediment, we concluded that white-tailed deer, American Robin, and raccoon were the species with the greatest potential for exposure to on-site contaminants. In conclusion, we believe our conservative approach to exposure quantification for the terrestrial organisms provides adequate screening for all species in the area.

Comment 60: Page 48, Section 3.2.4

Additional bird species should be selected as target organisms since numerous species were reported to occur at each site. Similar to the mammals and herpetofauna, each ecological guild and/or niche should be evaluated even though individual home ranges may be much larger than a particular site. As such, additional bird species to consider are various waterfowl (ducks, geese, herons, etc.), raptors (hawks, falcons, etc. due to the bioconcentration effects of certain chemicals), insectivorous birds, fruit and seed eating birds. Additionally, special considerations needs to be made for migrating species, especially for the chemicals which have a high tendency to bioaccumulate.

Response 60: See response to comment #59.

Comment 61: Page 49, Section 3.3

Can surface waters be sampled to get a direct measurement of chemicals of concern? Modeling is generally a useful indicator, however, since basic water quality parameters such as pH, temperature, hardness, etc. are unknown, it makes the model assumptions even more uncertain.

Response 61: As recommended in Section 6., surface water samples will be collected at some sites during Phase-II to confirm the low constituent concentrations predicted here. Modelling was not meant to take the place of data collection, but was used here to provide conservative estimates of surface water concentrations where such data were lacking.

Comment 62: Page 51, Section 3.3.2

We suggest a re-evaluation not including inhalation as a potential pathway in light of sediment deposition from flooding.

Response 62: We assume that the comment should read ".. a re-evaluation, including inhalation..". Inhalation has been added as a pathway for all sites where volatile organics were detected. As noted in response to comment 52, we do not feel that fugitive dust emissions is an important pathway relative to potential exposures derived from other routes.

Comment 63: Page 52, Section 3.3.2

Does the ingestion pathway include contaminated soil that may be ingested due to preening and grooming behaviors? If not, revise so that it is included. Additionally, state references for deriving ingestion rates for each species and how fractions of soil, water, plant and animal were derived. Also, list reference for body weight for each species of concern.

Response 63: Yes, preening and grooming behavior is included. This is clarified in Appendix III.

Comment 64: Page 55, Section 4.2

The USFWS has published studies on the toxicity of various chemicals on wildlife. these studies are part of the "Contaminant Hazard Reviews" and available from the Patuxent Wildlife Research Center. These reviews should be used to supplement the RTECS information as it may be more species specific for wildlife. Additionally, explain how a safety factor of "5" was derived. Is it adequate for all species? Likewise, explain the rationale behind using correction factors of 5 and 10 when extrapolating to NOAEL from chronic and acute toxicity tests.

Response 64: Incorporated suggestions into the revised report.

Comment 65: Page 55, Section 4.3

Refer to the USFWS documents mentioned above (comment 64) for additional references for vegetation toxicity.

Response 65: As mentioned in Section 4.3, there is little available information on the effect of soil contamination on plant toxicity for the constituents identified here. The USFWS documents focus on effects on fish, wildlife and invertebrates and provide little toxicological information that pertain to plants. Thus, in the absence of specific information and given the preliminary nature of this study, we assumed that terrestrial plants would be protected if aquatic organisms were protected.

Comment 66: Page 57, Section 5.0

For clarification, please redefine each equation component.

Response 66: Clarified discussion in revised report.

Comment 67: Is there any separation for carcinogenic versus noncarcinogenic compounds?

Response 67: Clarified discussion in revised report.

Comment 68: Page 58, Section 5.1, paragraph 2

Was the highest detected concentration of a chemical at a site used or was some average or median value used?

Response 68: Clarified discussion in revised report.

Comment 69: Page 62, Section 6.1

Additional water quality data and microinvertebrate studies would be of great use in substantiating the claim that there are no adverse environmental impacts for these sites to confirm the low levels predicted here.

Response 69: As noted in response to previous comments (e.g., 10, 13), we do not feel that benthic invertebrate studies would provide evidence of contaminants at these sites. We have added recommendations to collect water quality samples at appropriate sites to confirm the low levels predicted here.

Comment 70: Page 63, Section 6.2

Include a microinvertebrate study to determine the presence/absence of pollution sensitive species.

Response 70: See response to comment 69. As recommended in the report, we feel that toxicity tests plus tissue analysis would provide more useful information on exposure and effects than community structure analysis.

Comment 71: Page 63, Section 6.3

State the results of the computed ERI for each target species. Explain why an ERI was not computed for the raccoon (a listed target species). Discuss the results of the computed ERIs for each target species and how they compare to acceptable levels. Compute ERIs for other target species (listed above) to ensure that the conclusions are correct for all species occurring at the site.

Response 71: Raccoons were not selected as a receptor for site 11A, as noted in section 3.2.1 and 3.2.3. Discussion has been expanded in revised report.

Comment 72: Page 64, Section 6.4

Was a sample collected of the black anoxic sediments observed in a drainage ditch at this site? A sample is needed to confirm that aquatic life is not affected in this ditch. Additionally, were the potential carcinogenic effects of some VOCs considered separately as an adverse toxic affect? A separate discussion of carcinogenic effects should be included. Also discuss possible impacts to animals that are in direct contact with stream sediments (i.e., raccoon, beaver, etc.) and may ingest the contaminated sediments.

Response 72: See response to comment 29. Carcinogenic effects were not considered separately. As noted in Section 4.0, critical toxicity values were based on NOAEL computed from all toxicity data (acute and chronic) reported in the databases that were screened. This is consistent with the conservative approach followed in this study.

Comment 73: Page 64, Section 6.5

Please state how the conclusion that the consumption of tainted prey was determined to be the chief pathway of concern. What about direct ingestion of contaminated soil as a result of grooming and preening behaviors? ERIs should be computed for all target species known to occur at the site. Additionally, discuss in greater detail the toxic effects of dioxins and furans to wildlife and why even small amounts of these chemicals can be devastating to wildlife. Also include a separate discussion for carcinogenic effects for PAHs.

Response 73: The conclusion concerning the consumption of tainted prey has been clarified as has direct ingestion via other routes. See response to comment 59 concerning other species. The focus of Section 6 is recommendations for future work. We do not feel that additional discussion on dioxins and PAHs are relevant here.

Comment 74: Page 64, Section 6.6

Please state and discuss the results of the computed ERIs for each target species. We suggest focusing on the degree and severity of the risk to wildlife at this site (i.e., immediate danger, highly susceptible populations, etc.). Include a discussion of carcinogenic effects. Be specific as to the sampling strategy (i.e., locations of samples, additional studies, probable analytes, etc).

Response 74: Incorporated suggestion into revised report.

Comment 75: Table 2

We suggest including all species (including vegetation and aquatic life) of concern such as rare, Federal Category 2, etc.

Response 75: Incorporated suggestion into revised report.

Comment 76: Table 12

Arsenic and Beryllium should also be included.

Response 76: Incorporated suggestion into revised report.

Comment 77: Table 13

Channel catfish is listed as a potential receptor but no ERI values were ever calculated. List all potential receptors or have more general categories in this table (i.e., burrowing mammals, predatory birds, etc.).

Response 77: Incorporated suggestion into revised report.

Comment 78: Table 15

Show the equation of how the CTV was derived and the references on which it is based.

Response 78: Incorporated suggestion into revised report.

Comment 79: Table 16

Same comment as #81.

Response 79: Incorporated suggestion into revised report.

Comment 80: Table 17

Same comment as #81.

Response 80: Incorporated suggestion into revised report.

Comment 81: Table 18

Show the equations of the individual ERIs and how they were derived.

Response 81: Incorporated suggestion into revised report.

Comment 82: Table 19

Same comment as #81.

Response 82: Incorporated suggestion into revised report.

Comment 83: Table 20

Same comment as #81.

Response 83: Incorporated suggestion into revised report.

Comment 84: Table 21

Same comment as #81.

Response 84: Incorporated suggestion into revised report.

Comment 85: Table 22

Same comment as #81.

Response 85: Incorporated suggestion into revised report.

Comment 86: Appendix II

The TEQs for site 22A were not referenced. Please reference.

Response 86: Incorporated suggestion into revised report.

Comment 87: Appendix II

White-Tailed Deer (Site 10) - Water Ingestion Rate should be increased because site vegetation is not all succulent. To be consistent with the conservative approach taken throughout the document, an intake of 3.5 liters/day is more appropriate. Additionally, water intake may vary with seasons. Also, describe the method used to estimate the soil ingestion rate.

Response 87: Incorporated suggestion into revised report.

Comment 88: Appendix II

Raccoon (Site 10) - Change water ingestion rate to liters/day. Also, for soil ingestion rate, must also consider grooming and food washing behaviors which may increase this assumption.

Response 88: Incorporated suggestion into revised report.

Comment 89: Appendix II

White-Tailed Deer (Site 11A) - Compare the site habitat to surrounding habitats to determine which areas the deer are more likely to frequent. Revise water intake per comment #87. Also, rainfall data should be referenced to determine the average number of days with a measurable rainfall. This also applies for the American Robin.

Response 89: Incorporated suggestion into revised report.

Comment 90: Appendix II

White-Tailed Deer (Site 14) - Compare the site habitat to surrounding habitats to determine which areas the deer are more likely to frequent. Revise water intake per comment #87. State the reasoning behind assuming the fraction of water derived from the site is 50 percent.

Response 90: Incorporated suggestion into revised report.

Comment 91: Appendix II

American Robin (Site 14) - Please clarify whether site residency is 120 or 150 days.

Response 91: Incorporated suggestion into revised report.

Comment 92: Appendix II

White-Tailed Deer (Site 22A) -- Same as comment #90.

Response 92: Incorporated suggestion into revised report.

Comment 93: Appendix II

American Robin (site 22A) -- Same comment as #91.

Response 93: Incorporated suggestion into revised report.

Comment 94: Appendix II

White-Tailed Deer (Site 36) -- Same comment as #90.

Response 94: Incorporated suggestion into revised report.

Comment 95: Appendix II

Raccoon (Site 36) -- Same comment as #88.

Response 95: Incorporated suggestion into revised report.

C. Response to Comments by USEPA dated October 18, 1993 on Quality Control Summary Report

GENERAL COMMENTS

Comment 1: It is recommended that the various analytical results be provided with the same labels as requested for sample quantitation limits. Providing data in this manner would aid in avoiding confusion in reviewing the data. This would mean that all inorganic results would be provided in mg/kg and all other results would be in $\mu\text{g/kg}$. The recommendation would also conform to standard reporting conventions as found in other reports of a similar nature. The current report contains explosives in Table 3 as mg/kg and in Table C as $\mu\text{g/kg}$. Continuity in label use is recommended.

Response 1: Concur. All organic data will be reported in $\mu\text{g/kg}$.

Comment 2: The quality control report should also discuss the operations for instrument calibration, use of internal standards, qualitative identification of tentatively identified compounds (TICs), ICP serial dilution, and other areas of system performance and sample result verification. These items directly effect data quality. If the laboratory instrumentation is not functioning properly, the results may be invalid even if other quality control criteria are met.

Response 2: Concur. The text will be revised to incorporate comment suggestions. The case narratives address any deviations or nonconformances with instrumentation or system performance. These criteria were reviewed in accordance with the QAPP and had there been a nonconformance it would have been mentioned in the text of the QCSR. As per the QAPP, these data were deemed acceptable for the intended use of the data. As per the QAPP, TICs were not required for this project. According to EPA 540 G-87-003 Data Quality Objectives for Remedial Response Activities (page B-5), these project data are considered sufficient for the intended use of the data.

Comment 3: Section 2.3 indicates the RI was conducted to confirm or verify the nature and extent of contamination at the various on-site locations. Two of these on-site locations are the Solvent Storage Drainage Ditch and the Industrial Park Drainage Ditch. Section 2.6 also seems to indicate that HNu or other PID instrumentation would be used to perform site characterization through real-time monitoring. The reviewer has interpreted this to mean that VOC sample field screening was to have been performed on-site. The PID results shown in Appendix B, Table 3, indicate positive hits or elevated levels of organic vapors were observed at these two drainage ditch locations (sample locations COSO1401, COSO1601, and COSO1603). Samples were not analyzed for volatile organic compounds at these locations and therefore the on-site sample screening appears to be not as effective or utilized as possible. It is recommended that these locations be

sampled to determine the nature and extent of contamination revealed as probable by the PID field screening measurements.

Response 3: Appendix B, Table 3 indicates headspace measurements were taken on all grab aliquots that comprised composite samples as per the SAP. This method is summarized in Section 2.2.2.1 of the Phase I RI report. As indicated in Section 2.2.2.1 and in the SAP, field headspace screening of the 5 aliquots was used to determine where the discrete VOC sample would be obtained from within the composite sample area. Aliquots for composite samples COSO11A01, COSO11A02, COSO11A03, COSO11A04, COSO1201, COSO1202, COSO1401, COSO1601, and COSO1603 with the highest headspace reading lead to the selection of specific locations for the collection of discrete samples COSO11A05, COSO11A06, COSO11A07, COSO11A08, COSO1203, COSO1204, COSO1402, COSO1602 and COSO1604, respectively, for VOC analysis. Criterion other than headspace screening (as per the SAP) were used to select the specific location for the discrete samples at Sites 7, 7A, 8, 9, 10, 11, 20, 22A and 36 and Sample COSO1404 at Site 14.

Comment 4: The data quality may be satisfactory while the use of the data may need to be qualified as less than satisfactory. For example, the discussion of precision in Section 5 indicates that the exceptions are most likely due to matrix heterogeneity or poor laboratory spiking technique. These results were determined to not have been impacted by these nonconformances. If the sample is not properly homogenized prior to removing the aliquot for sample analysis, the resultant value will not be representative of the entire sample. Similarly, if the laboratory is having difficulty with spiking techniques, they may also experience problems with sample surrogate spiking. Surrogate recovery concerns are also noted in the project samples, especially with the pesticide analysis.

Response 4: Concur. Samples were homogenized for the semivolatile and inorganic parameters in the laboratory prior to preparations for analysis. These samples were also homogenized in the field prior to submittal to the laboratory. Inconsistent spiking techniques by the laboratory are likely, as the associated LCSs results were within acceptance limits. According to the case narratives and based on conversations with the laboratory personnel there were no laboratory protocol nonconformances; therefore, the reviewer was unable to make a definite conclusion as to the source of this nonconformance. Therefore, these results were re-evaluated and the text will be changed to reflect appropriate qualifications based on this further evaluation. The discussion of the pesticide analysis results evaluation will be expanded to indicate that the reason for surrogate nonconformances were due to dilutions required to quantitate target analytes detected in the associated samples.

The discussion of the decision process for data validation will be expanded to include the following information. For samples that had low surrogate recovery, the associated sample data were qualified as estimated. For samples that had high surrogate recovery, the associated non-detect were

not qualified and detectable results were qualified as estimated and biased high. For analyses where no surrogates were available (explosives), MS/MSD and LCS data were evaluated to determine sample specific and batch QC results. Additionally, a majority of the MS/MSD and surrogate nonconformances were attributed to high concentrations of target analytes which required dilutions for quantitation of these detectable quantities thus resulting in low recovery of spike compounds. If MS/MSD or surrogate recoveries were above the control limits, nondetect results were not qualified and positive detects were considered estimated with a positive bias. The COSL3605MS/MSD recoveries for explosives were below the acceptance limits criteria (Table 5-2) and the LCS recoveries were within acceptance limits (Table C-3). The control limits are default limits and are quite narrow (75-125%). Based on this information the results for sample COSL3605 will be qualified as estimated for explosives due to the low recoveries. The remaining samples were not qualified since the associated LCS were within the acceptance limits.

The project data with associated data qualifiers are presented in Attachment 1 to this document. These data met the data quality objectives of this project and, therefore, are considered usable. The text will be revised to clarify the results of the evaluation and the conclusions.

SPECIFIC COMMENTS

Comment 1: Pages 5-2, 5-3, Sections 5.1.1.5 - 5.1.1.6. These sections indicate the nonconformances did not impact the data quality for the effected analyses. It is believed there may be an impact, but it cannot be easily defined on the basis of the matrix spike duplicate and RPD alone. A statement that there was not impact at all may be a bit bold.

Response 1: According to USEPA Functional Guidelines (June 1991), "no action is taken on MS/MSD data alone. However, using informed professional judgement the data reviewer may use the MS and MSD results in conjunction with other QC criteria and determine the need for some qualification". The text will be changed to read as follows: "This nonconformance was attributed to matrix heterogeniety and elevated concentrations of target analytes; therefore, positive detectable quantities were qualified as estimated values". There were no qualifications of nondetect results.

Comment 2: Page 5-2, Section 5.1.1.5. This section indicates the nonconformance is due to degradation of the standard. This nonconformance should be identified as a calibration problem. All related sample results should be qualified accordingly as estimated (J).or unusable (R), as appropriate.

Response 2: This nonconformance is not a calibration error since the calibration standards were within acceptable limits. The MS standard solution had degraded; therefore, the MS/MSD result was below the acceptance limit. The text will be revised to reflect this clarification. The field sample associated with this MS/MSD were qualified as estimated based on this nonconformance. The sample results associated with this MS/MSD were

qualified as estimated for tetryl due to recovery results that were below 10%.

Comment 3: Pages 5-4, 5-5, Section 5.1.2.1 - 5.1.2.6. These sections indicate that various sample results are to be considered estimates. It should be made clear in the text that the results are coded (J or UJ) in Table 5-5. It is recommended that, due to the zero recovery for both pesticide surrogates, the pesticide sample results for sample COSO3604 should be considered as unusable (R) per the guidance document. Poor surrogate recoveries may be attributed to laboratory deficiencies in surrogate spiking technique.

Response 3: Concur. The text will be changed to reflect the requested clarification with regard to the coding of the results in Table 5-5. Sample COSO3604 had high levels of target analytes detected including PCBs which required dilution to meet quantitation requirements; therefore, the surrogates could not be recovered. The text will be modified to reflect this clarification.

Comment 4: Page 5-6, Section 5.1.3.6. The use of blank analyte levels is not appropriate. If the sample result is less than five times the level found in the associates blank, the sample result can be considered to be nondetected (U). These values are not to be considered background levels as stated in the report. The analysis of background samples determines background levels. These concentrations do effect the way the data is reported. This item should be addressed in the qualified results provided in this report.

Response 4: The levels detected in the method blank samples were low level (<5 times the amount found in the samples) and these analytes were not contaminants of concern; therefore, sample results greater than the reporting limit for these analytes, but less than five times the amount found in the blank samples, were qualified as non-detect (U). Any mention of background levels will be deleted in this section. The text will be changed to reflect this clarification.

Comment 5: Page 5-6, Section 5.1.4. The section indicates the goal set for completeness was 90 percent for all QC parameters. The goal set, according to Section 4.2.4, is that 90 percent of all field sample results must meet the QC criteria. If each parameter were to be considered separately, explosives would not pass since 8 (as found in Table 5-7, not 9 as listed in 5.1.4) out of 76 samples, including the QA splits, failed the holding time criteria. The actual numbers of sample results were not tallied. However, due to the large numbers of organic compounds required for analysis, the 90 percent goal has probably been achieved.

Response 5: Concur. Eight samples did miss the advisory holding times required in the QAPP. It is important to note that the 14 day holding time for sample extraction is an advisory holding time. None of the samples exceeded the advisory holding time by more than 2 days. According to the MRD Laboratory Report (Appendix D to the QCSR), holding times were met for

all split sample analyses (Item 1.e. Holding Times). The results of the QA splits are comparable to the results of the field samples. The comparability of QA split data results for explosives support the interpretation that explosive compounds would not degrade significantly two days past the 14 day holding time, considering the samples were properly preserved (cooled) at the laboratory. Therefore, the results are considered acceptable. The overall project completeness was achieved when considering split sample results for explosives. The text will be revised to identify this clarification.

Comment 6: Page 5-6, Section 5.1.5. Acetone was qualified in sample COSL3603 due to QA split sample comparison. Section 1.0 states that the QA split samples were not available and therefore not discussed in this report. It is recommended that any acetone qualification in this report be based upon information obtained relative to the laboratory performing the analysis. There was no other indication that acetone should be considered as estimated (J) at this level in this sample. The qualified results table should be corrected to reflect this change.

Response 6: Section 1.0 was a typographical error. The text will be changed to reflect the correction. According to the USEPA Functional Guidelines (June 1990), the results of the samples were qualified by elevating the limit of detection when the sample concentration is less than 10 times the blank concentration. Additionally, in instances where little or no contamination was present in the associated blanks, qualification was deemed necessary when variances were identified in other results, such as QA split results. The text will be modified to reflect this clarification.

Comment 7: Page 5-7, Section 5.1.5. The last paragraph states that "the data are comparable to the previous sampling round." There should be a discussion as to how this determination was reached and upon what information this conclusion was based.

Response 7: Concur. These data are of known and acceptable quality since standard methods, standard units, and standard calibration criteria were utilized. Based on this information, these data may be compared to other data utilizing standard operating protocols. The text will be modified to reflect this clarification.

(08726652.wp1/srh)



IN REPLY REFER TO.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Marion Illinois Suboffice (ES)

Rural Route 3, Box 328

Marion, Illinois 62959

(618) 997-5491



November 15, 1993

Illinois Environmental Protection Agency
Attn: Crab Orchard Project Manager
Division of Land Pollution Control
Federal Sites Management Unit
Attn: Stephen Nussbaum
2200 Churchill Road
P.O. Box 19276
Springfield, Illinois 62794-9276

Dear Mr. Nussbaum:

Enclosed for your review are four (4) copies of the Draft Response to Agency Comments for the Phase I Remedial Investigation Report and Quality Control Summary Report for the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge (CONWR), Marion, Illinois. The substance of these comments will be discussed at the November 19, 1993 meeting, here at the CONWR, at 10:00 am. We hope that you will be able to attend, especially if you have questions regarding the responses.

If you have any questions, please contact me at (618) 997-5491.

Sincerely,

R. Mark Sattelberg
Superfund Project Manager
Crab Orchard National Wildlife Refuge

Enclosure

cc: Eugene Liu, USACE w/o enclosure
Nan Gouda, USEPA w/o enclosure
Frank Fischer, USACE w/o enclosure



IN REPLY REFER TO

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Marion Illinois Suboffice(ES)

Rural Route 3, Box 328

Marion, Illinois 62959

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November 15, 1993

U.S. Environmental Protection Agency, Region 5
Attn: Nan Gowda (HSRL-6J)
Crab Orchard Project Manager (IN/IL Section)
77 West Jackson Boulevard
Chicago, Illinois 60604

Dear Mr. Gowda:

Enclosed for your review are four (4) copies of the Draft Response to Agency Comments for the Phase I Remedial Investigation Report and Quality Control Summary Report for the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge (CONWR), Marion, Illinois. The substance of these comments will be discussed at the November 19, 1993 meeting, here at the CONWR, at 10:00 am. We hope that you will be able to attend, especially if you have questions regarding the responses.

If you have any questions, please contact me at (618) 997-5491.

Sincerely,

R. Mark Sattelberg
Superfund Project Manager
Crab Orchard National Wildlife Refuge

Enclosures

cc: Eugene Liu, USACE w/o enclosure
Steve Nussbaum, IEPA w/o enclosure
Frank Fischer, USACE w/o enclosure

Comments and Revised Responses

Draft Phase-I RI Report
Miscellaneous Areas Operable Unit
Crab Orchard NWR, Marion, Illinois

A. Comments from IEPA dated September 28, 1993, and Responses by Golder Associates

Comment 1: An objective of the RI must be to identify any and all areas where hazardous waste exist. This means the samples which are collected from the soils, sediments, leachate, seeps, ponded liquids and groundwater should be analyzed per the TCLP test as well as tests for pH, flashpoint and reactivity in order to determine if they are characteristically hazardous wastes. In addition, the review of the site history should include reviewing the processes which generated the wastes at the site in order to determine if listed hazardous wastes were deposited there. Regulatory classification of the materials and the wastes at the site is necessary in order to properly identify the ARARs for any remedial action.

Response 1: In response to the first part of this comment regarding analysis for TCLP; the objective of Phase I of the RI, as defined in the Scope of Services prepared by the DOI and USACE and reiterated in the Project Work Plans approved by the Agencies, is to assess the presence or absence of contamination at certain sites. At the appropriate time in the RI, some chemical analyses will be performed to help evaluate remedial alternatives and to help identify ARARs associated with the disposition of hazardous waste.

During Phase I, it was premature to analyze samples for TCLP when the presence and extent of contamination was not yet determined. During Phase II, TCLP analyses will be included in the analytical program for sites where hazardous constituents are believed present in concentrations above levels of concern and the probable remediation technology requires the analyses, (e.g., the sludges present in the East Pond at the Wastewater Treatment Facility (Site 36)). This approach conforms with the process described in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (U.S.EPA, 1988).

The IEPA had a similar comment on the Project Work Plans at the March 1993 project meeting in St. Louis. The IEPA withdrew the comment after discussion and agreement about the intended procedures for the Misc AOU RI.

In response to the portion of the comment regarding review of the site history; the 1987 Remedial Investigation Report (O'Brien and Gere, 1988) investigated the operational histories for the Phase-I sites. The historical information was incorporated in the scoping process and Project Work Plans for the 1993 RI.

Comment 2: The RI should identify the extent of wastes (hazardous and nonhazardous) at the site on a scale drawing(s), so that the horizontal and vertical extent of the contamination is readily discernable.

Response 2: Phase II of the RI will be designed to further delineate the extent of potentially contaminated areas that contain concentrations above level of concern.

Comment 3: Samples should not be composites. This applies for all samples.

Response 3: Composite samples were used to in Phase I, and to a lesser extent in Phase II, to confirm the presence or absence of the compounds of concern. This use of composite samples for this exact purpose is suggested in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (U.S.EPA, 1988). This approach is described in the Project Work Plans approved by the Agencies.

In addition, we feel that if the area in which the composite sample was collected is smaller than an area in which cleanup activities can be reasonably implemented it is irrelevant if the sample consists of more than one aliquot. We feel that a composite sample from a small area is actually better than a discrete sample because it effectively deals with heterogeneities of the soil materials and erratic distribution of the chemical constituents. For these reasons, the analytical results of a composite sample from a small area (such as a 12-foot square) are more reliable to use for risk assessment and remedial design.

Where appropriate, Phase-I composite samples will be reevaluated by collecting discrete samples during Phase II.

Comment 4: The attached NPDES guidance may be appropriate for future work undertaken with respect to the Miscellaneous Operable Unit.

Response 4: Thank you for providing the information.

Comment 5: There appears to be a consistency problem regarding the number of areas which are part of the Miscellaneous Areas Operable Unit. The number of areas appears to include Site 22A as previously included in this miscou. This is not correct. Site 22A is associated with the wood treatment operations conducted at the Refuge. It is adjacent to the Old Refuge Shop which is part of the Metals Areas Operable Unit. This was discussed during the September Project Manager's Meeting. Please revise the documents such that consistency is maintained.

Response 5: The FFA includes 22 sites in the Misc AOU: Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 13, 14, 18, 16, 20, 21, 24, 25, 26, 27, 30, 31, 34 and 35. The FFA does not mention the Post Treating Facility (a.k.a., Site 22A). Because the site is included in the Scope of Services for the Misc AOU provided to Montgomery Watson/Golder Associates by the USACE/DOI, it is included in the Misc AOU RI. Golder Associates assigned it site number 22A, with the prior approval of DOI, during preparation of the project Work Plans.

The FFA requires, in addition, investigations of the wastewater treatment plant and stream sediment downstream of the plant in Dove Creek and Pigeon Creek as part of the Misc AOU, but recognizes that the areas are not formally part of the Misc AOU. The site number 36 was assigned to the wastewater treatment plant and downstream areas by Golder Associates, with the prior approval of DOI.

In the revised Phase-I RI Report, we will clearly indicate which sites are included in the Misc AOU.

As provided in the FFA, the DOI will provide a letter to the appropriate Parties of the FFA requesting that Sites 22A and 36 be formally included in the Misc AOU.

Comment 6: References to sample concentrations in the text should also include the depth and sample numbers for the concentration being discussed.

Response 6: Depth and sample numbers will be incorporated into the revised text where concentrations are referenced.

Comment 7: The document does not appear to recognize the fact that samples were composites. Being such, there remains the possibility that one of the five samples used for the composite may contain five times the detected concentration of the compound which was reported. The report should be revised to incorporate this possibility and recommendations of additional work may need to be modified. In addition, composite samples should not be used in the baseline risk assessment, unless acute effects have been evaluated based on the potential of one of the five samples used for the composite sample containing five times the concentration of the constituent or the detection limit.

Response 7: Additional discussion will be added to the text to address the possible dilution associated with composite samples. Please note that discrete samples were, however, collected for all VOC analyses and for analysis of all parameters for samples collected from the ponds and the lagoon at Site 36.

For the composite samples, there is the possibility that one of the aliquots contains more than the other four aliquots; the worst-case scenario is that for a reported parameter one aliquot contains five times the detected concentration and four aliquots contained no detectable amount of the

reported parameter. This scenario is applicable to the TCL semivolatile organic compounds (SVOC), PCBs and pesticides, explosives, dioxin and furans, and cyanide because they, typically, are not naturally present in soils. A likely scenario for metals is discussed below.

We have reviewed the analytical results for the organic compounds of Phase-I composite samples using the assumption that concentrations of applicable organics (e.g. SVOCs, PCBs and pesticides, explosives, and dioxins and furans) and cyanide were diluted five-fold, and whether concentrations - after adjusting for such a dilution - would exceed PLCs. Based on our review, we determined that Site 16 contains PCB compounds that could theoretically exceed the PLC adopted for the Phase-I RI. At Site 16, detected concentrations of Aroclor 1254 and Aroclor 1260 were 103 ug/kg and 61 ug/kg, respectively, in Sample COSO1603 which was collected along the drainage ditch. Five times the detected total PCB concentration is 820 ug/kg, which exceeds the PLC for total PCBs of 500 ug/kg. Based on this approach to assessing the analytical results, and the results of the Preliminary Ecological Assessment, Phase II activities in the drainage ditch at Site 16 are warranted; specific activities will be described in the Phase-II Work Plan.

In reviewing the results using the five-fold dilution assumption, no other composite samples exceeded the PLCs for SVOCs, pesticides and PCBs, explosives, dioxins and furans, or cyanide.

Evaluating the potential dilution of metals requires a different approach because metals are naturally present in soils. Typically, soils within the Refuge area will contain metal concentrations that are within the range of the background samples. Each aliquot of a composite sample would, therefore, contain metals and the reported concentration of the composite sample would essentially be the mean concentration of the five aliquots.

We have reassessed the metals analyses assuming that four aliquots each have a concentration at the lower end of the range for background, with the fifth aliquot containing an amount equal to five times the total reported concentration less the sum of the four lean aliquots. Note that cadmium was reassessed based on a revised PLC value of 0.83 mg/kg (background mean plus two times the standard deviation) in response to a USEPA comment on the Site 22A Work Plan.

As a result of reassessing the Phase-I TAL metal analyses using the dilution scenario identified above, beryllium, cadmium, and thallium exceed PLC values in all composite samples in which the respective metal was detected, and arsenic exceeds the PLC in 27 of the 35 composite samples that were analyzed. The assessment using the dilution scenario indicates that there are 59 more PLC exceedances for these four metals than identified in the Draft Phase-I RI Report. For each of the four metals, the total number of PLC exceedances using the reassessment procedure relative to the Draft RI Report procedures, is as follows:

- arsenic exceeded the PLC in 27 samples rather than one sample (Site 11);
- beryllium exceeded the PLC in 12 samples rather than 5 (one sample from each of Sites 7, 8, 9, 11 and 14);
- cadmium exceeded the PLC in 11 samples rather than 6 (using the PLC of 0.83 mg/kg, samples exceeding the PLC included COSO1401, COSO1601, COSO1603, COSO22A03, COSE3601 and COSE3609); and
- thallium exceeded the PLC in 32 samples rather than 11 (Sites 9, 11A, 12, 14 and 22A).

In summary, the assessment using the above dilution scenario for the four metals does not discern between naturally occurring (background) and potential anthropomorphic concentrations; therefore, it is not a useful screening tool. A statistical analysis of the concentrations of these four metals in Phase-I soil and sediment samples indicates that the metals each have essentially the same mean and standard deviation as the background samples. The similarity of the means and standard deviations indicate that Phase-I samples metal concentrations are representative of natural levels.

The upper end of the range of the beryllium and cadmium concentrations in the Phase-I samples is slightly higher than the background samples. The higher Phase-I sample concentrations of these metals could be caused by inclusion of till or loess materials which, according to the USACE background data presented in Appendix B of the Draft RI Report, have higher beryllium and cadmium concentrations than local soils.

In the Revised Phase-I Report, the results of reassessing the metal concentrations will be discussed in Section 6.1 for each of the sites with at least one sample which exceeded the PLC for arsenic, beryllium, cadmium and/or thallium. Additional discussion of the background concentrations may be included in Section 3.5.

We also disagree with the last part of the comment regarding use of composite samples in the Baseline Risk Assessment; we feel that their use is appropriate without being adjusted for the potential dilution when the aliquots are collected in a relatively small area in order to reduce sampling bias associated with matrix heterogeneity and erratic distribution of analytes (as described in the response to Comment no. 3). Composite samples taken in these situations are acceptable for use in the risk assessment, according to Risk Assessment Guidance for Superfund, Volume I, Part A, Section 4.6.3 (U.S.EPA, December 1989).

Comment 8: Sample results should be incorporated into the figures. Concentrations above the PLC should be presented next to the sample locations in the figures.

Response 8: Detected concentrations with sample locations are provided in Figures 14 through 21 for Sites 10, 11, 14, 22A and 36. Concentrations exceeding PLC's are highlighted in these Figures. Figures showing concentrations for samples collected/analyzed from Sites 7, 7A, 8, 9, 12, 16 or 20, were not prepared because PLCs for organics were not exceeded and inorganic concentrations were typically below background, with a select number of inorganic parameters slightly above the background derived PLC.

Comment 9: The site visit conducted in October of 1992 has been given too much weight with regard to concluding that no further investigation and/or sampling is required. There has been no factual justification provided in any of the documents which evaluates these areas with regard to areal photographs or other methods to determine appropriate locations. Furthermore, the absence of no specific target analytical sampling is not quite accurate. The Final RI Report must evaluate these sites (21, 25 and 35) based on the information generated in the 1988 RI by O'Brien and Gere and the information collected during the Phase I and II sampling currently being conducted. If DOI feels there is sufficient information to evaluate these sites in the Final RI and complete a baseline risk assessment, DOI may choose not to further investigate these sites. However, should there not be sufficient data of sufficient quality to complete the Final RI Report and conduct the baseline risk assessment, IEPA will not concur with DOI's conclusions. This is a decision that can only be made by DOI.

Response 9: It is appropriate to address this comment by beginning with a point of clarification and then discuss the investigative history of the three sites.

Preliminary Site Visits were performed at Sites 21, 27 and 35 (as stated on pages i, 2, 13, and 30 of the Draft RI Report), not at Site 25.

Previous investigations at the three sites (O'Brien and Gere, 1988) consisted of site ground inspections, sampling and analysis, plus one or more of the following activities: aerial photographic analysis, interviews, and surface geophysics.

As a result of the RI activities, O'Brien and Gere concluded that Sites 21 and 35 "... do not represent a chemical exposure risk to human or wildlife receptors at the refuge or at other locations"... and that "... no further evaluation is recommended".

Site inspections completed on October 27 and 28, 1993, consisted of visual examination to look for evidence of past or present contamination (e.g., stained soils, stressed vegetation, off-colored or unusual odors from seeps or in surface water bodies). No signs of contamination were observed during the inspections of Sites 21 or 35.

The two sites were also inspected on July 23, 1993, as part of the Preliminary Ecological Risk Assessment. During these inspections, no evidence of contamination was observed. The Preliminary Ecological Risk

Assessment concluded that at Sites 21 and 35 there is little likelihood of potential ecological risk and that no further sampling is warranted.

Since the 1988 RI and the recent RI activities do not provide evidence that contamination is present, the USACE and DOI see no reason to consider performing sample collection and analysis at Sites 21 or 35. A Preliminary Risk Assessment will be completed for the two sites as part of the Final RI Report; however Baseline Risk Assessments will not be performed for a site, unless the results of the Preliminary Risk Assessment indicate that the site poses a threat to human health or the environment. This approach conforms with the goals of an RI/FS as stated in the National Contingency Plan (40 CFR Part 300). The NCP includes the recommendation to focus "the remedial analysis to collect only additional data needed to develop and evaluate the alternatives and support design".

For Site 27, the 1988 RI concluded that sediment samples did not have compound concentrations above control (background) sites, but surface water samples from Crab Orchard Creek exceeded secondary MCLs for iron and magnesium. They recommended that quarterly monitoring be completed of surface water for cyanide, magnesium, manganese, TOC and TOX (Attachment 1 of O'Brien and Gere). Continued monitoring of Site 27 sediments was not recommended.

During a site inspection, on October 28, 1993, to look for evidence of past or present contamination, no signs of contamination were observed.

We did not include Site 27 sampling and analysis activities in the Phase-I Work Plan because the river sediment and surface water currently present at the site area represent materials from upstream facilities (e.g., Interstate highway 57 and the Marion POTW) that are not part of Refuge and are not relevant to the historical aspects of the site being investigated as part of the present RI. For these reasons, no further action was the chosen course of action presented in the Draft Work Plan for Site 27. The IEPA had opportunity to formally comment on the Draft Work Plan; furthermore, the purpose of the March 3, 1993 strategy meeting in St. Louis was to discuss the Draft Work Plan. IEPA comments concerning Site 27 raised on these two occasions were addressed in the Revised Project Work Plans and were, therefore, approved by the Agency.

Floodplain areas of Site 27 were inspected on July 23, 1993, as part of the Preliminary Ecological Risk Assessment. During the inspection, no evidence of contamination was observed. The Preliminary Ecological Risk Assessment concluded that at Site 27 there is little likelihood of potential ecological risk and that no further samples need to be collected.

Based on the results of Site 27 investigations, no further RI activities are planned for the site.

Comment 10: Page 9; Site 13 is not identified in Figure 8. Please incorporate this site into Figure 8. If there is a more appropriate figure to place Site 13 into please modify that figure.

Response 10: Site 13 is located on Figure 2 and will be added to Figure 8.

Comment 11: Section 1.6 should also include the contaminants or elevated concentrations of constituents found during the previous investigations for each of the areas encompassed in the miscou.

Response 11: To make the report succinct and avoid redundancy Section 1.6 includes a summary of previous investigations and Section 5.2 describes the specific results for each site, including compounds detected during the previous and the present RIs. This conforms with the suggested RI Report format in Guidance for Conducting RI/FS under CERCLA (U.S. EPA, 1988).

Comment 12: In Section 2.1, the second sentence is awkward. As previously stated in comments regarding the Sampling and Analysis Plan (Golder Assoc., December 1992), it is not appropriate to view the site visit conducted October 27, 1992, in the light that the SAP, and now the Phase I RI Report, seem to be presenting it. DOI must be able to provide a strong justification of this decision based on the technical evidence available. Such justification consists of areal photographs and previous site investigations. Without additional sampling, the only data available to include in the RI Report and risk assessment will be the 1988 RI by O'Brien and Gere. To date, there has been no such compelling justification presented which would allow IEPA to evaluate whether there is sufficient data of sufficient quality to characterize the sites and complete a baseline risk assessment.

Response 12: It is not clear to us what is awkward about the following sentence: "The site visits consisted of visual examinations of each site area to look for evidence of past or present contamination, review the results of previous investigations, and discuss the sites."

DOI intends to use available data to complete a Preliminary Risk Assessment on Sites 21 and 35 as part of the Final RI Report; no further RI activities are planned for Site 27. Baseline Risk Assessments for the three sites are not planned.

Comment 13: Section 2.2.1, the fourth paragraph states that the June samples were taken adjacent to the May sample locations. What is meant by "adjacent"? Also, were the June samples collected pursuant to the SAP?

Response 13: June samples were collected within one foot of the May samples and in conformance with approved SAP procedures. The text will be revised to reflect this.

Comment 14: In Section 3.4, the first sentence in the second paragraph should have "typically" inserted between "are" and "less".

Response 14: Agreed. The text will be revised accordingly.

Comment 15: Section 3.5:

- a. Background determinations for inorganic constituents should include samples from areas unaffected by activities which could result in elevation of the levels of these constituents. Since most of the samples included in Appendix B were part of the Explosives/Munitions Manufacturing Areas Operable Unit (EMMAOU), a justification that these samples/areas have not been impacted by the Department of the Army or other activities which would result in elevated concentrations of inorganic constituents is required. At a minimum the justification should include a map identifying sample locations, sample results for other constituents (i.e. VOC, SVOC, TNT, RDX, etc.), sample calculations and inorganic constituents potentially affected by site activities.
- b. As previously discussed in relation to the Crab Orchard National Wildlife Refuge, the documents for each operable unit must contain all of the pertinent information required to review and evaluate the findings presented in the document. In this case, the background determination for inorganic constituents does not supply sufficient information to evaluate the findings presented in the document.
- c. Conclusions based on the determination of background should be reserved for the Final RI Report. Decisions which are no further investigation is warranted should be based on the potential need for additional data to complete the baseline risk assessment, not on preliminary levels of concern.

Response 15 a & b: Section 3.5 of the Revised Phase-I RI Report will include the following discussion: "The USACE database contains 36 soil, loess and till samples collected from borings, trenches and the surface. The database samples are believed to represent the background range of the 23 TAL metals because no samples were included in the database that 1) contain explosive compounds or high levels of organic compounds, and 2) were collected from zones that contain rubble, metal or other visual signs of disturbance. In addition, five of the database samples were background samples for the Explosive and Munitions Areas Operable Unit (EMMAOU) Phase-I RI. The remaining 31 samples were EMMAOU Phase-I RI field samples. The similarity in the range of metal concentrations between the background samples and the field samples supports the assumption that the field samples have not been impacted by anthropomorphic sources of metal and, therefore, the metal concentrations represent natural levels."

A map of the sample locations will also be included in the Revised Phase-I RI Report. As in the Draft Phase-I RI Report, the Revised Phase-I RI Report will include a description of the database, including metal analyses and a description of the statistical methods and results.

- c. The risk that each site poses to human health and the environment will be assessed in the Final RI Report and/or the Preliminary Risk Assessment. The limitations (for general screening purposes) of using the PLCs for assessing the sites is stated in the last paragraph of page 32 in the Draft Phase-I RI Report.

Comment 16: Section 5.2.6, the text states five compounds were detected below their respective PLCs. However, the text does not indicate those compounds detected above the PLC. Please revise the text to incorporate those compounds above their respective PLCs.

Response 16: The first sentence of Section 5.2.6 states that three SVOCs were detected at concentrations above their PLCs: benzo(a)anthracene, benzo(b)fluoranthene and bis(2-ethylhexyl)phthalate. Reported concentrations are also provided in tabular form on page 34, along with their respective PLCs.

Comment 17: Section 5.2.13:

Sections 3.8 and 3.9 identify potential exposure pathways (fish, livestock, and wildlife) that require the evaluation of the bioaccumulation of the Dioxin/Furans. Based on the bioaccumulation pathway, the PLC for these compounds should be 6 ppt. This concentration is substantially less than the 1 ppb identified in the report as the PLC. The 1 ppb PLC is based on the residential exposure scenario.

Response 17: This will be addressed in the Preliminary Risk Assessment.

Comment 18: In the first complete paragraph on page 32, reference should be changed to Appendix B.

Response 18: Comment noted. The text will be revised accordingly.

Comment 19: Section 6:

- a. Toxic Equivalency Factor for the Dioxin should be calculated and presented.
- b. As stated in previous comments regarding composite samples, the detection of a constituent (i.e. TNT at Site 11A) could also be concluded that one of the sample locations used for the composite

sample has a concentration equal to five times the concentration reported for the composite sample. This approach should also be presented so that an informed decision about whether additional samples are warranted can be made. Composite samples should not be used in the risk assessment.

Response 19: a. The TEF will be included in the Final RI Report and in the Preliminary Risk Assessment.

b. Refer to comment response no. 7. Also, the results of the Ecological Risk Assessment indicate that Site 11A poses no risk to the local ecology; therefore, Phase-II investigations will be not be planned at Site 11A.

Comment 20: In Section 6.3, the indicator scoring which was completed and the results presented in this section should be tabulated and included as an appendix in the document. Sample calculations should also be presented.

Response 20: The method and results of the indicator scoring will be included in Section 6.3 or in an appendix of the Revised Phase-I RI Report.

Comment 21: None provided.

Response 21: No response required.

Comment 22: Section 7.1, Site 16 states that no TAL inorganics were detected. This is not correct. Please revise the text as appropriate.

Response 22: Comment noted, text will be corrected.

Comment 23: Section 7.2 contains one of the major flaws which has resulted in the current problems being faced in the Metals Operable Unit. Further sampling should not be limited to specific compounds. Additional sampling for the miscou should include, at a minimum, TCL/TAL. The cost savings for running select groups (i.e. Site 10 (TCL SVOC parameters) is minimal.

Response 23: We do not feel that using TCL and TAL for all sample analyses is warranted for Phase II. Analysis of samples using the TCL and TAL in Phase I has established the general nature of compounds present at sites. Phase II sampling and analysis will focus on the confirming the presence and the vertical and lateral extent of compounds detected at site that contained (during Phase) concentrations that exceed PLCs or are determined to be at levels that may pose a potential risk, based on the Preliminary Ecological Assessment. The Phase II analyses would include the parameters detected during Phase I. Various suites of parameters (e.g. Volatiles, PCB's etc.) not detected at site during Phase I would not be

included in the Phase-II analytical program. Complete TAL and TCL analyses will be completed on some of the Phase II samples in order to verify previous results (especially composite sample results) and provide evidence that additional compounds of concern are not being overlooked.

This approach conforms with the RI/FS goals discussed in the National Contingency Plan (40 CFR Part 300). The NCP states in Section 300.430(a)(1) that the "...goal, expectations and management principles incorporated into the (NCP) promote the tailoring of investigatory actions to site specific needs". To ensure that the RI/FS ... "is conducted as effectively and efficiently as possible", the NCP includes the recommendation to focus "the remedial analysis to collect only additional data needed to develop and evaluate the alternatives and support design". Since the RI results indicate that certain compounds are present at the sites, Phase II will focus on those parameters.

Comment 24: Site 10:

- a. Does not address the potential need to collect samples from the embayment of Crab Orchard Lake into which the surface water and sediment would be deposited. If the Phase II sampling proposed between the lake and Site 10 indicates contamination and the extent can not be delineated, a Phase III investigation of the embayment would be required.
- b. Narrowing the list of analytes to TCL SVOC parameters is not appropriate. This methodology has lead to the current issues being discussed regarding the Metals OU and the PCB OU. The discrete samples proposed should include TAL/TCL plus Explosives.
- c. Episodic overflow onto the nearby flood plain does not appear to be addressed by the additional sampling proposed.
- d. Potential groundwater contamination has not been addressed. The Phase II sampling should include at least one monitoring well placed in the unconsolidated till/loess in the apparent down gradient direction. Placement of the well should be as close as possible to the area investigated in Phase I. Should groundwater contamination be discovered, additional monitoring wells and piezometers would be required.

Response 24:

- a. The analysis of a sediment sample collected where the creek meets Crab Orchard Lake is planned and will be described in the Phase-II Work Plan. If the sample does have compounds at concentrations of concern, collection and analysis of a sample from the embayment will be considered.
- b. Please see response to comment no. 23.

- c. Will be addressed in the Revised Phase-I Report.
- d. No groundwater sampling and analysis is planned as such investigations are not warranted based on Phase I results. As described in Section 6.4.1, it is unlikely that groundwater is a significant pathway because of the physical properties of the compounds detected in concentrations above PLC levels (i.e., SVOCs) and the typical direction of groundwater flow in the area (i.e., towards surface water bodies).

Furthermore, the Preliminary Ecological Risk Assessment does not recommend groundwater sampling because concentrations in water would only be a small fraction of that in solid phase samples (given the high K_{ow} of the compounds) and groundwater concentrations would likely be below analytical detection limits.

If the Phase II sample results indicate higher concentrations of the compounds of concern and that groundwater may be potentially impacted, groundwater investigations will be considered.

Comment 25: Site 11A:

- a. Narrowing the list of analytes to Explosive parameters is not appropriate. This methodology has led to the current issues being discussed regarding the Metals OU and the PCB OU. The discrete samples proposed should include TAL/TCL plus Explosives.
- b. Potential groundwater contamination has not been addressed. Groundwater contamination has been documented at other sites on the Refuge as a result of Explosives contaminated soils. The Phase II sampling should include at least one monitoring well placed in the unconsolidated till/loess in the apparent down gradient direction. Placement of the well should be as close as possible to the area investigated in Phase I. Should groundwater contamination be discovered, additional monitoring wells and piezometers would be required.

- Response 25:
- a. Please see response to comment no. 23.
 - b. The Preliminary Ecological Risk Assessment concludes that there is little potential for ecological risk from levels of TNT detected at the site and recommends that no additional samples be collected. Thus, we are not planning to collect and analyze any Site 11A samples during Phase II.

Comment 26: Site 14:

- a. Narrowing the list of analytes to BETX parameters is not appropriate. This methodology has lead to the current issues being discussed regarding the Metals OU and the PCB OU. The discrete samples and groundwater samples should include TAL/TCL plus Explosives.
- b. What is meant by "shallow groundwater". There must be a more accurate description provided.

Response 26: a. Please see response to comment no. 23.

- b. Shallow groundwater refers to the uppermost aquifer (i.e., the water table) and is likely to be encountered within approximately 20 feet of the ground surface at Site 14. The text will be revised to incorporate a more detailed description of anticipated groundwater conditions.

Comment 27: Page 60 is before page 59 in the documents supplied to IEPA.

Response 27: The correction will be made for the revised submittal.

Comment 28: Site 22A:

- a. Narrowing the list of analytes to Dioxin and TCL SVOC parameters is not appropriate. This methodology has lead to the current issues being discussed regarding the Metals OU and the PCB OU. The discrete samples and groundwater samples should include TAL/TCL plus dioxin/furan compounds.
- b. What is meant by "shallow groundwater". There must be a more accurate description provided.

Response 28: a. Please see response to comment no. 23.

- b. Shallow groundwater or the uppermost aquifer at Site 22A will likely be encountered within 5 to 10 feet of ground surface. The text will be revised to incorporate a more detailed description of anticipated groundwater conditions.

Comment 29: Site 36:

- a. The sampling proposed for this site does not appear to address surface water contamination within the drainage areas and lake. Incorporate surface water samples for TAL/TCL and explosives.

- b. Narrowing the list of analytes to TCL SVOC, TCL PCBs, cadmium, lead and thallium or other limited parameters indicated for areas within this site is not appropriate. This methodology has lead to the current issues being discussed regarding the Metals OU and the PCB OU. The discrete samples and groundwater samples should include TAL/TCL and explosives.
 - c. What is meant by "shallow groundwater". There must be a more accurate description provided.
- Response 29:
- a. Surface water sampling of the East Pond, Dove Creek and Pigeon Creek will be addressed in the Revised Phase-I RI Report. Please refer to the response to comment no. 23 regarding the analytical program for the surface water samples. Crab Orchard Lake is being monitored by organizations under the guidance of the DOI/FWS and, therefore, lake water (and/or sediment) sampling and analysis are not planned as part of the Misc AOU.
 - b. See comment response number 23.
 - c. Shallow groundwater in the Site 36 area is likely less than 15 feet below ground surface. The text will be revised to incorporate a more detailed description of anticipated groundwater conditions.

B. U.S.FWS Comments Dated 10/19/93

Comment 1: Page 4, Section 1.3. Crab orchard National Wildlife Refuge does not enter into Johnson County.

Response 1: The text will be revised accordingly.

Comment 2: Page 4, Section 1.4. Last sentence in second paragraph should read: "... as one of its four purposes" rather than "... central to its vitality".

Response 2: The comment will be addressed by revising the text as recommended.

Comment 3: Page 4, Section 1.4. Last sentence should read: "... in the closed portion" rather than "... in the eastern portion".

Response 3: Agreed. The text will be revised accordingly.

Comment 4: Page 9, Section 1.6.3.2. Site 13 is located southeast of Site 14.

Response 4: Agreed. The text will be revised accordingly.

Comment 5: Page 11, Section 1.6.7. Last sentence should include the USEPA and IEPA.

Response 5: Agreed. The text will be revised accordingly.

Comment 6: Page 28, Section 3.8. Acres described do not add up to 43,500. Lake acreage should be included.

Response 6: The comment will be addressed by including all appropriate acreage in the revised text.

Comment 7: Page 28, Section 3.8. Last sentence of first paragraph should read: "Most of this usage occurs on the western and southwestern portion of the Refuge, which is remote from the manufacturing areas located in the closed portion".

Response 7: Agreed. The text will be revised accordingly.

Comment 8: Figure 12. Change the location of the Headquarters building to the present location or label Site 22A at the "old or former" Headquarters building.

Response 8: Figure 12 will be revised to identify the present location of the headquarters.

(08726625.wp1/srh)

APPENDIX B
BACKGROUND DATA BASE FOR METALS IN SOILS

AUG 19 1993

923 2108
Crab Orchard
NWR
Marion Illinois

MEMORANDUM

TO: Steve White
FROM: P. Anderson
DATE: August 6, 1993

SUBJ: Database for metals, Crab Orchard, Illinois.

Executive Summary

A statistical database of analyses of twenty-three metals was compiled for soil and rock samples from Crab Orchard, Illinois. The database was used to calculate the average, maximum, minimum, and standard deviation values for these samples. Additional soil samples may be combined with assumed background soil samples to determine the overall background concentrations of metals in the area and till contains higher concentrations of metals than either soil and loess. These latter two types of material are virtually indistinguishable at the site and from boring log descriptions.

Introduction

A database was compiled of geochemical metal concentration data from selected soil samples collected at Crab Orchard, Illinois. This database was used to assist in defining simple univariant statistical parameters for samples of undisturbed unconsolidated materials not contaminated by military or industrial activities at the site. The averages, maximums, minimums, and standard deviations were calculated for the twenty-three metals for each group of samples. This database may be used for additional statistical analyses of the data if necessary.

Method

A Lotus 123 format database was provided to the U. S. Army Corps of Engineers by Environmental Science and Engineering, Inc. (ESE) St. Louis, Missouri. This database contained geochemical values for explosive and organic compounds and metals for 146 samples. The majority of these samples were soil samples collected from the surface, soil borings, and trenches. Ground water, surface water, and sediment samples were also included in the data set.

The USACE database contains 39 samples which do not contain explosive compounds or high levels of organic compounds. Ground water, surface water, and sediment samples were excluded from the data set. In addition, samples were compared with boring logs to determine if there was any visual evidence of contamination. Those

samples that were collected in zones that contained rubble, metal, or other signs of disturbance were not included in the final data set. Each sample was analyzed for twenty-three metals: Al, Fe, Ca, K, Na, Mg, Mn, Ba, V, Cr, Zn, Ni, Pb, Co, Cu, Be, As, Ta, Sb, Se, Ca, Ag, and Hg. Samples were sorted based on lithological type into six subgroups: unconsolidated material, soil, loess, till, sandstone, and coal. The unconsolidated material subgroup contains 36 samples representing all soil, loess, and till samples. The soil subgroup is composed of 24 samples consisting of background samples, soil samples obtained from soil borings and trenches, and surface samples from site COC-4. The loess and till subgroups are composed of samples from monitoring well borings and contain 8 and 4 samples, respectively. The monitoring well boring logs were the only available source of information to aid in determining the potential origin of these samples based on lithological descriptions. Loess was defined as soil which contained fine-grained sand and was near the surface. Till included soils encountered in the lower portions of borings which contained gravel. The sandstone subgroup contains one sample while the coal subgroup contains two samples.

The geochemical data for several metals was below the lower detection limit for several of the samples in the data set. A value of one half the lower detection limit was used for the calculation of statistical parameters for these values. In addition, sample COC-MWS-9*3 was removed from the data set. This sample contained the maximum and minimum values for several of the metals and was removed to reduce the skewness of the sample populations due to high and low outlier values. Sample COC-MWS-9*3 represents a sample of till.

Discussion

The raw data for the UASCE database of metal analyses is in Appendix A. The averages, maximums, minimums, and standard deviations for the one half the lower detection limits data set is in Table 1. Background and soil samples display similar concentrations of metals (Figure 1). This relationship supports the assumption that these subgroups may be used collectively for statistical analyses of background metal concentrations in soils at the site and increases the effective sample population for soils from 5 to 24 samples. Till has the highest concentrations of metals relative to loess and soil, especially with metals of lesser abundance (Figure 2). The concentrations of metals in loess is slightly higher than the concentrations of metals in soils.

The accuracy of the statistical parameters generated by this database are dependent on the quality of sample collection and handling and the quality control of the analytical laboratory. These parameters are assumed to be adequate. However, the geochemical data for the metals Sb, Cd, and Hg can not be used in statistical analyses since greater than fifty percent of these

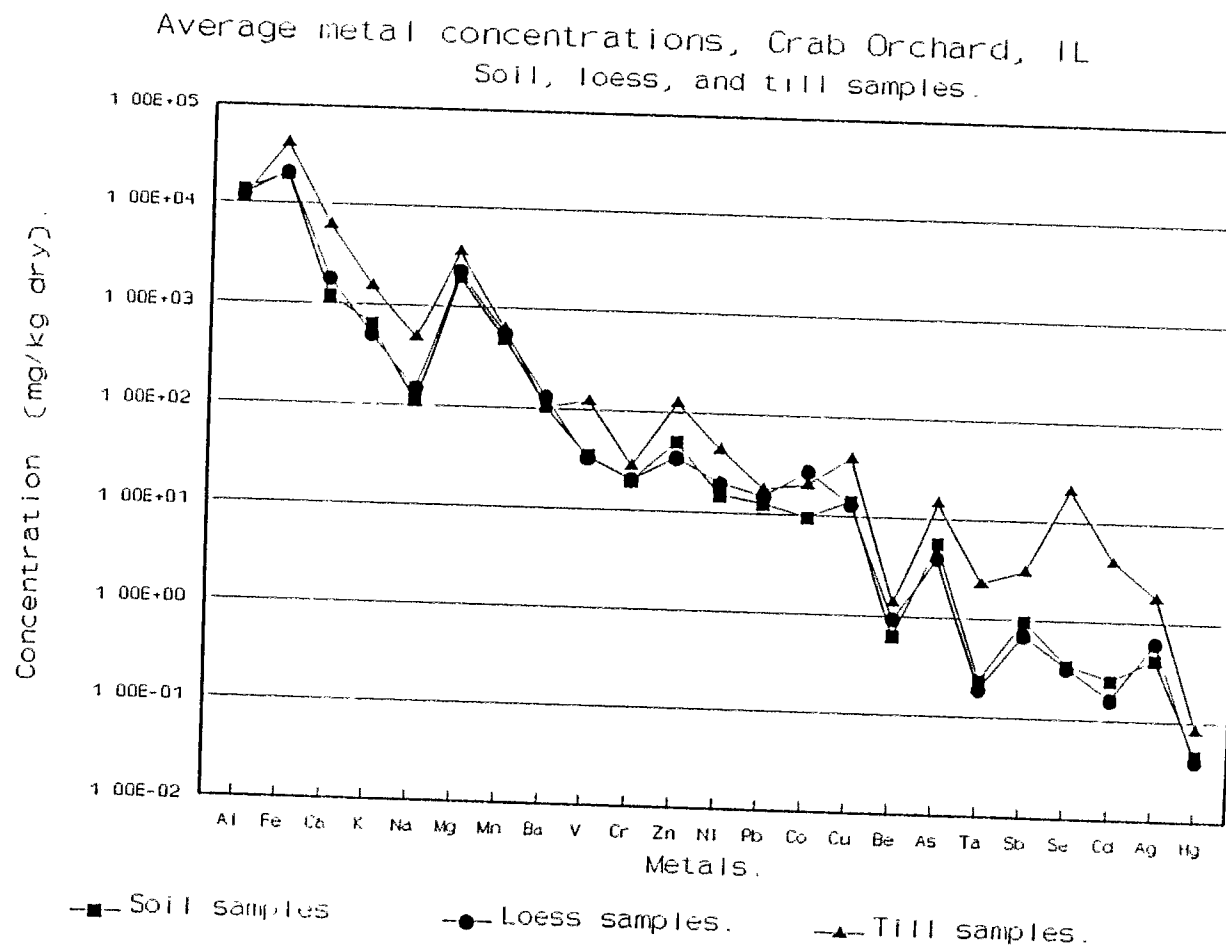
sample values are less than the lower detection limits of the analytical procedures. The limited amount of descriptive lithological information hinders the determination of the possible types of materials. This may result in the omission or inclusion of extraneous samples in subgroups.

Table 1. Averages, maximums, minimums, and standard deviations for metals for the data set subgroups, Crab Orchard, Illinois. Concentration in mg/kg dry weight.

METAL	Background samples (n=5)				Soil samples (n=24)				Loess samples (n=8)			
	Average	Maximum	Minimum	Standard Deviation	Average	Maximum	Minimum	Standard Deviation	Average	Maximum	Minimum	Standard Deviation
ALUMINUM	14998	28700	9400	7135.069	13590.42	28700	7340	4729.334	12147.5	25600	8740	5155.375
IRON	19960	28000	13500	5584.478	19912.92	30800	8410	5752.956	20600	37000	15100	7086.783
CALCIUM	917.2	1040	849	77.25128	1195.833	2250	645	427.4897	1811.25	4180	1140	943.7616
POTASSIUM	751.8	1590	201	474.8652	649.4583	1590	130	356.3049	510	1370	240	338.3345
SODIUM	134.99	173	10.95	62.17781	112.3521	451	10.95	94.30142	149.025	363	54.6	93.40618
MAGNESIUM	2642	4120	1520	972.2633	1990.417	4120	1130	694.3971	2253.75	3410	1650	473.047
MANGANESE	552.6	1340	237	399.5546	494.8333	1340	116	286.265	564	986	313	209.1937
BARIUM	129.6	160	102	22.57964	105.8625	160	59.2	27.04735	133.6125	176	88.9	27.10353
VANADIUM	33.46	55.2	24.3	11.33289	35.35417	96	17.3	15.46779	33.525	49.5	27.6	6.653899
CHROMIUM	19.78	29.8	12.9	5.710131	20.25375	42.9	8.89	7.240128	20.55	30.7	16	4.595378
ZINC	49.44	61.3	31.5	11.49741	50.8375	208	22.1	34.55638	35.2125	48.4	28.3	5.698122
NICKEL	18.24	23.4	14.3	3.112941	15.28958	34.8	6.51	5.628486	20.0375	40.2	16.1	7.669573
LEAD	15.886	18.8	9.53	3.563311	12.83833	21.1	6	3.941625	15.325	32.1	10.3	6.883994
COBALT	9.91	11.7	8.09	1.355625	9.660833	18.6	3.66	3.653725	28.14875	130	6.38	39.81471
COPPER	16.68	21.1	10.4	3.76797	14.40042	19.5	7.73	3.362714	13.5	22.9	10.9	3.649315
BERYLLIUM	0.622	0.77	0.53	0.081584	0.637083	0.86	0.43	0.108569	0.9575	2.91	0.55	0.743635
ARSENIC	5.592	8.02	2.75	2.323079	5.736667	15.5	1.76	3.047757	4.03	5.97	2.51	1.297748
THALLIUM	0.254	0.37	0.06	0.108185	0.238333	0.63	0.055	0.128854	0.1925	0.3	0.11	0.065527
ANTIMONY	0.743	0.775	0.695	0.02874	0.971875	2.41	0.64	0.521204	0.690625	0.725	0.66	0.023108
SELENIUM	0.302	0.48	0.1	0.16594	0.351333	1.5	0.001	0.299375	0.328125	0.93	0.1	0.244412
CADMIUM	0.115	0.12	0.105	0.005477	0.254167	1.35	0.1	0.29294	0.163125	0.57	0.1	0.153825
SILVER	0.536	0.69	0.45	0.082365	0.41875	0.8	0.11	0.175364	0.625	0.99	0.46	0.177553
MERCURY	0.04606	0.04895	0.04205	0.002252	0.04636	0.057	0.0339	0.004868	0.041044	0.0498	0.03135	0.006242

METAL	Till samples (n=4)				Sandstone samples (n=1)				Coal samples (n=2)			
	Average	Maximum	Minimum	Standard Deviation	Average	Maximum	Minimum	Standard Deviation	Average	Maximum	Minimum	Standard Deviation
ALUMINUM	11174	19000	3270	4984.406	7080	7080	7080	0	28100	31800	24400	3700
IRON	41280	60200	23500	13605.79	102000	102000	102000	0	32900	40000	25800	7100
CALCIUM	6106	17900	2490	5934.68	2000	2000	2000	0	4065	5940	2190	1875
POTASSIUM	1555.4	3460	397	1048.605	804	804	804	0	5595	9610	1580	4015
SODIUM	493.6	1210	236	363.6661	177	177	177	0	245.5	383	108	137.5
MAGNESIUM	3553.8	6590	289	2048.407	1150	1150	1150	0	3870	4870	2870	1000
MANGANESE	624.58	1620	18.9	544.4693	428	428	428	0	291	308	274	17
BARIUM	103.84	144	62.9	29.63434	83.9	83.9	83.9	0	121.5	142	101	20.5
VANADIUM	122.24	441	26.9	160.1198	42.6	42.6	42.6	0	697.5	1270	125	572.5
CHROMIUM	28.56	43.7	17	9.443068	27	27	27	0	145.65	245	46.3	99.35
ZINC	124.38	267	46.7	78.43878	221	221	221	0	782	1340	224	558
NICKEL	43.76	62.1	26.1	13.75741	49.6	49.6	49.6	0	129.2	214	44.4	84.8
LEAD	18.04	22.4	11.7	3.95707	14.5	14.5	14.5	0	21.95	26.6	17.3	4.65
COBALT	20.516	49	4.28	15.13273	27.1	27.1	27.1	0	10.63	13.1	8.16	2.47
COPPER	39	83.1	16.2	24.93335	25.9	25.9	25.9	0	68.4	115	21.8	46.6
BERYLLIUM	1.412	2.52	0.13	0.783694	1.88	1.88	1.88	0	1.315	1.95	0.68	0.635
ARSENIC	14.828	30.7	4.34	11.91092	3.32	3.32	3.32	0	22.375	35.5	9.25	13.125
THALLIUM	2.314	9.71	0.15	3.726793	0.45	0.45	0.45	0	3.09	5.3	0.88	2.21
ANTIMONY	3.128	11.8	0.695	4.352386	5.1	5.1	5.1	0	13.38	26.1	0.66	12.72
SELENIUM	21.255	104	0.1	41.37514	0.1	0.1	0.1	0	8.865	15.8	1.93	6.935
CADMIUM	4.112	12.4	0.105	4.48939	7.65	7.65	7.65	0	26.13	47.3	4.96	21.17
SILVER	1.81	5.86	0.56	2.031138	1.63	1.63	1.63	0	2.3555	4.09	0.621	1.7345
MERCURY	0.0844	0.201	0.0535	0.058309	0.109	0.109	0.109	0	0.14175	0.231	0.0525	0.08925

Figure 2. Comparison of soils, loess, and till average metal concentrations, Crab Orchard, Illinois.



Appendix A

Raw data for USACE database for metals at
Crab Orchard, Illinois

Table 1. Raw data for USACE database, Crab Orchard, Illinois.

SAMPLE	ID	COLL.	DATECOLL.TIME	PARLIST	PARAMETER
CO-BACK*1	SSBG-1-3-5		10/03/91 08:45	CO-9	CONC MG/KG DRY
CO-BACK*2	SSBG-2-0-2		10/03/91 10:00	CO-9	CONC MG/KG DRY
CO-BACK*3	SSBG-2-3-5		10/03/91 10:13	CO-9	CONC MG/KG DRY
CO-BACK*5	SSBG-3-3-5		10/03/91 08:45	CO-9	CONC MG/KG DRY
CO-BACK*4	SSBG-2-7-10		10/03/91 10:50	CO-2	CONC MG/KG DRY
COC-1MWS*1	MWSCOC1-1-5-7		09/25/91 07:55	CO-1	CONC MG/KG DRY
COC-1MWS*2	MWSCOC1-1-12-14		09/25/91 08:25	CO-1	CONC MG/KG DRY
COC-1MWS*3	MWSCOC1-1-19-21		09/25/91 09:38	CO-1	CONC MG/KG DRY
COC-2MWS*1	MWS-COC2-1-5-7		10/01/91		CONC MG/KG DRY
COC-2MWS*2	MWS-COC2-1-12-14		10/01/91 16:00		CONC MG/KG DRY
COC-4MWS*1	MWSCOC4-1-5-7		09/23/91 12:54	CO-1	CONC MG/KG DRY
COC-5*9	TPCOC5-2-4-6		08/22/91 10:58	CO-2	CONC MG/KG DRY
COC-5*10	TPCOC5-1-4-6		08/22/91 09:22	CO-2	CONC MG/KG DRY
COC-5MWS*1	MWSCOC5-1-5-		09/30/91 12:25	CO-1	CONC MG/KG DRY
COC-6MWS*1	MWS-COC6-2-5-7		09/30/91 12:15	CO-1	CONC MG/KG DRY
COC-6MWS*2	MWS-COC6-2-5-7		09/30/91 12:15	CO-1	CONC MG/KG DRY
COC-6MWS*3	MWS-COC6-2-12-14		9/30/91 15:30	CO-1	CONC MG/KG DRY
COC-6MWS*4	MWS-COC6-2-19-21		9/30/91 16:15	CO-1	CONC MG/KG DRY
COC-7*6	TPCOC7-2-4-6		08/26/91 16:32	CO-2	CONC MG/KG DRY
COC-9*9	TPCOC9-2-4-6		08/22/91 15:20	CO-1	CONC MG/KG DRY
COC-9*15	TPCOC9-2-0-2		08/22/91 14:55	CO-2	CONC MG/KG DRY
COC-9*20	TPCOC9-3-4-6		08/23/91 08:48	CO-2	CONC MG/KG DRY
COC-9MWS*1	MWS-COC9-2-5-7		09/25/91 08:50	CO-1	CONC MG/KG DRY
COC-9MWS*2	MWS-COC9-2-12-14		9/25/91 09:45	CO-1	CONC MG/KG DRY
COP-4*16	TPCOP4-7-0-2		09/04/91 10:40	CO-1	CONC MG/KG DRY
COP-4*26	TPCOP4-2-4-6		08/27/91 15:15	CO-1	CONC MG/KG DRY
COP-4*17	TPCOP4-3-8-10		08/28/91 10:22	CO-3	CONC MG/KG DRY
COP-4*25	TPCOP4-5-6-8		09/03/91 14:40	CO-3	CONC MG/KG DRY
COC-4SS*1	SSCOC4-1		09/08/91 09:35	CO-3	CONC MG/KG DRY
COC-4SS*2	SSCOC4-2		09/08/91 09:35	CO-3	CONC MG/KG DRY
COC-4SS*3	SSCOC4-3		09/08/91 10:15	CO-3	CONC MG/KG DRY
COC-4SS*9	SSCOC4-9		09/11/91 09:25	CO-3	CONC MG/KG DRY
COC-4SS*4	SSCOC4-4		09/08/91 10:45	CO-1	CONC MG/KG DRY
COC-4SS*5	SSCOC4-5		09/08/91 12:10	CO-1	CONC MG/KG DRY
COC-4SS*6	SSCOC4-6		09/08/91 12:45	CO-1	CONC MG/KG DRY
COC-4SS*7	SSCOC4-7		09/08/91 13:40	CO-1	CONC MG/KG DRY
COC-4SS*8	SSCOC4-8		09/08/91 14:20	CO-1	CONC MG/KG DRY
COC-4SS*10	SSCOC4-10		09/11/91 09:55	CO-1	CONC MG/KG DRY
COC-4SS*11	SSCOC4-11		09/11/91 10:25	CO-1	CONC MG/KG DRY

BACK = background

SSBG = surface sample, background

MWS = monitoring well sample

TP = test pit sample

Table 1. (Cont.)

SAMPLE	1105*SCLP1097*SCLP1002*SCLP1007*SCLP1012*SCLP1027*SCLP					
	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM
CO-BACK*1	14900	-1.47	8.02	125	0.63	-0.23
CO-BACK*2	9690	-1.39	2.99	160	0.61	-0.21
CO-BACK*3	28700	-1.48	6.18	151	0.77	-0.23
CO-BACK*5	12300	-1.55	8.02	110	0.57	-0.24
CO-BACK*4	9400	-1.54	2.75	102	0.53	-0.24
COC-1MWS*1	8740	-1.34	5.68	131	0.7	-0.21
COC-1MWS*2	10200	-1.45	5.97	88.9	0.87	-0.22
COC-1MWS*3	11700	1.69	6.49	144	1.73	4.04
COC-2MWS*1	9140	-1.38	3.16	111	0.55	-0.21
COC-2MWS*2	11200	-1.49	4.61	77.3	1.55	-0.23
COC-4MWS*1	10700	-1.42	4.34	62.9	2.52	3.9
COC-5*9	15000	-1.29	2.86	124	0.65	0.25
COC-5*10	20500	-1.43	5.34	147	0.66	0.37
COC-5MWS*1	10500	-1.44	2.58	147	0.59	0.57
COC-6MWS*1	11300	-1.33	3.21	145	0.64	-0.2
COC-6MWS*2	11300	-1.32	2.51	176	0.74	-0.2
COC-6MWS*3	19000	-1.39	28	114	1.13	-0.21
COC-6MWS*4	7080	5.1	3.32	83.9	1.88	7.65
COC-7*6	17300	-1.36	2.62	72.5	0.64	-0.21
COC-9*9	31800	26.1	35.5	142	1.95	47.3
COC-9*15	24400	-1.32	9.25	101	0.68	4.96
COC-9*20	17400	-1.61	15.5	77.3	0.86	1.35
COC-9MWS*1	10400	-1.38	4.03	160	0.66	-0.21
COC-9MWS*2	25600	-1.41	5.1	110	2.91	-0.22
COP-4*16	19700	-1.37	4.03	59.2	0.51	-0.21
COP-4*26	10500	-1.28	3.79	61.4	0.43	-0.2
COP-4*17	7340	-1.41	4.21	82.1	0.5	-0.22
COP-4*25	13000	-1.43	1.76	84.7	0.6	-0.22
COC-4SS*1	9650	1.8	7.87	84.7	0.68	0.7
COC-4SS*2	12600	-1.47	10.7	110	0.81	0.75
COC-4SS*3	10500	2.19	6.79	87.3	0.54	-0.22
COC-4SS*9	15300	-1.39	3.81	129	0.74	-0.21
COC-4SS*4	8970	1.83	3.65	134	0.55	-0.22
COC-4SS*5	9370	-1.42	4.08	83.5	0.61	0.38
COC-4SS*6	14400	2.41	7.22	113	0.62	0.43
COC-4SS*7	10600	-1.34	6.15	103	0.78	-0.21
COC-4SS*8	8650	1.49	7.21	102	0.58	-0.21
COC-4SS*10	14600	-1.48	8.48	122	0.82	-0.23
COC-4SS*11	15800	-1.5	3.65	116	0.6	-0.23

Table 1. (Cont.)

SAMPLE	916*SCLPS1034	*SCLP1037	*SCLP1042	*SCLP1018	*SCLP1051	*SCLP
	CALCIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD
CO-BACK*1	976	21.2	11.7	19.2	23000	18
CO-BACK*2	871	12.9	11.1	14.7	13500	18.8
CO-BACK*3	849	29.8	8.09	21.1	28000	14.4
CO-BACK*5	850	18.7	9.87	18	21500	18.7
CO-BACK*4	1040	16.3	8.79	10.4	13800	9.53
COC-1MWS*1	1560	16	9.01	12.9	16500	10.3
COC-1MWS*2	2200	17.3	39.9	13.6	26700	19.6
COC-1MWS*3	17900	32.8	18.6	49.9	46500	21.4
COC-2MWS*1	1420	17.2	6.38	11.5	16300	12
COC-2MWS*2	2530	17	17.9	16.2	23500	15.5
COC-4MWS*1	4330	20.5	49	24.7	60200	11.7
COC-5*9	1400	18.8	7.58	9.08	18300	10.5
COC-5*10	1330	22.3	10.4	17.7	23200	18
COC-5MWS*1	1330	17.8	8.1	11.9	15100	10.9
COC-6MWS*1	1300	20.8	9.2	10.9	17100	13.2
COC-6MWS*2	1360	24.5	12	12.8	19600	12
COC-6MWS*3	3280	28.8	12.8	21.1	28000	19.2
COC-6MWS*4	2000	27	27.1	25.9	102000	14.5
COC-7*6	1770	27.4	7.18	12.6	21600	15
COC-9*9	5940	245	13.1	115	40000	26.6
COC-9*15	2190	46.3	8.16	21.8	25800	17.3
COC-9*20	913	31.1	12.7	17.2	22500	18.6
COC-9MWS*1	1140	20.1	10.6	11.5	16500	12.5
COC-9MWS*2	4180	30.7	130	22.9	37000	32.1
COP-4*16	1120	23.1	5.02	12	18900	14.6
COP-4*26	2250	10.8	3.99	6.64	10100	7.73
COP-4*17	2010	8.89	3.66	6	8410	11.5
COP-4*25	1930	15.5	4.76	7.95	13600	9.75
COC-4SS*1	747	16.3	13.2	11.1	22900	13.8
COC-4SS*2	859	25.7	10.8	13.9	27900	13.7
COC-4SS*3	1080	14.2	7.4	10	14900	11.3
COC-4SS*9	1610	22.3	10.8	15.8	23300	16.2
COC-4SS*4	778	17.7	8.71	9.25	14000	11.6
COC-4SS*5	645	14.1	12.1	10.1	23100	12.2
COC-4SS*6	1180	19.8	8.55	16.3	20500	15.7
COC-4SS*7	919	21	17.7	13.4	27800	19.5
COC-4SS*8	903	15.2	11	10.1	16700	13.6
COC-4SS*10	1350	42.9	18.6	13.2	30800	19
COC-4SS*11	1320	20.1	8.16	12.4	19600	13.9

Table 1. (Cont.)

SAMPLE	927*SCLPS1055	*SCLP71900	*SCL1067	*SCLP937	*SCLPS1147	*SCLP
	MAGNESIUM	MANGANESE	MERCURY	NICKEL	POTASSIUM	SELENIUM
CO-BACK*1	3180	442	-0.094	19.6	890	0.46
CO-BACK*2	1520	1340	-0.0925	16.2	616	0.36
CO-BACK*3	4120	237	-0.0979	23.4	1590	-0.2
CO-BACK*5	2740	396	-0.0921	17.7	462	0.48
CO-BACK*4	1650	348	-0.0841	14.3	201	-0.22
COC-1MWS*1	2120	478	-0.0961	17	466	0.3
COC-1MWS*2	1650	986	-0.0868	19	436	0.34
COC-1MWS*3	6590	632	-0.107	40.4	1240	1.37
COC-2MWS*1	2090	313	-0.0889	17.9	240	-0.2
COC-2MWS*2	2980	577	-0.11	33.2	397	-0.2
COC-4MWS*1	3480	1620	-0.113	62.1	930	0.7
COC-5*9	1950	350	-0.0839	16.2	732	-0.21
COC-5*10	2800	473	-0.0942	18	1490	0.44
COC-5MWS*1	2060	610	-0.0679	17	254	0.35
COC-6MWS*1	2220	519	-0.0996	16.8	383	0.93
COC-6MWS*2	2290	408	-0.0825	16.1	394	-0.21
COC-6MWS*3	4430	275	-0.112	26.1	1750	-0.21
COC-6MWS*4	1150	428	0.109	49.6	804	-0.2
COC-7*6	1970	154	-0.108	14.6	730	0.29
COC-9*9	4870	274	0.231	214	9610	15.8
COC-9*15	2870	308	-0.105	44.4	1580	1.93
COC-9*20	2340	308	-0.104	34.8	838	1.5
COC-9MWS*1	2190	411	-0.0722	16.3	537	0.26
COC-9MWS*2	3410	787	-0.0627	40.2	1370	0.24
COP-4*16	2110	116	-0.114	11.2	921	-0.002
COP-4*26	1320	303	-0.0918	7.58	374	-0.21
COP-4*17	1130	231	-0.0905	6.51	130	-0.002
COP-4*25	1660	467	-0.0865	9.01	659	-0.2
COC-4SS*1	1360	837	-0.0678	13.1	386	0.41
COC-4SS*2	1730	644	-0.0797	16.5	479	0.45
COC-4SS*3	1560	386	-0.103	12.5	433	0.37
COC-4SS*9	2470	403	-0.0933	19.1	816	0.21
COC-4SS*4	1260	659	-0.0892	11.6	436	0.45
COC-4SS*5	1330	567	-0.0916	15.3	362	0.24
COC-4SS*6	2470	327	-0.0826	16	852	0.45
COC-4SS*7	1610	907	-0.0893	12.2	328	0.52
COC-4SS*8	1430	763	-0.105	9.55	247	0.72
COC-4SS*1	1820	956	-0.0903	16.3	676	0.27
COC-4SS*1	2240	262	-0.1	15.7	939	0.29

Table 1. (Cont.)

SAMPLE	929*SCLPS1059*SCLP1087*SCLP1092*SCLPS					TRPH
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	
CO-BACK*1	0.69	173	0.37	33.2	58.1	-
CO-BACK*2	0.51	-21.9	0.22	25.1	40.4	-
CO-BACK*3	0.54	159	0.31	55.2	61.3	-
CO-BACK*5	0.49	166	0.31	29.5	55.9	-
CO-BACK*4	0.45	166	-0.12	24.3	31.5	-15
COC-1MWS*1	0.46	186	0.3	28.2	37.2	-14
COC-1MWS*2	0.85	363	0.27	33.6	28.3	-15
COC-1MWS*3	0.93	257	1.36	70.8	123	-16
COC-2MWS*1	0.53	54.6	0.13	27.6	31	-14
COC-2MWS*2	0.56	405	0.19	26.9	46.7	-14
COC-4MWS*1	1	360	0.15	30.8	267	-15
COC-5*9	0.27	66.7	0.2	34.4	33.4	-15
COC-5*10	0.38	83.5	0.29	42.9	60.3	21
COC-5MWS*1	0.6	80	0.11	30.4	33.9	-14
COC-6MWS*1	0.52	119	0.22	32.5	31.7	-14
COC-6MWS*2	0.51	123	0.15	36.7	34.6	-14
COC-6MWS*3	0.7	236	0.16	41.7	58.2	-8.8
COC-6MWS*4	1.63	177	0.45	42.6	221	-15
COC-7*6	0.5	168	0.46	46.4	44.9	43
COC-9*9	4.09	383	5.3	1270	1340	21
COC-9*15	0.621	108	0.88	125	224	26
COC-9*20	0.58	131	0.63	96	208	-16
COC-9MWS*1	0.54	74.6	0.22	29.7	36.6	-14
COC-9MWS*2	0.99	192	0.14	49.5	48.4	-15
COP-4*16	0.64	82.9	0.18	37.3	39.8	-14
COP-4*26	0.25	451	-0.11	20.8	22.1	-16
COP-4*17	0.26	221	0.19	17.3	56.1	17
COP-4*25	0.31	224	0.34	26.9	39.5	-15
COC-4SS*1	0.29	36.2	0.14	28.4	54.1	-14
COC-4SS*2	0.25	34.2	0.15	36.4	54	-14
COC-4SS*3	-0.22	48.3	0.19	24.1	33	-14
COC-4SS*9	0.72	44.1	0.2	38.7	45.6	-14
COC-4SS*4	0.25	98.7	0.24	23.4	37.9	-15
COC-4SS*5	0.38	26.8	0.14	26.8	57.2	14
COC-4SS*6	0.25	24.9	0.36	34.9	46.4	-15
COC-4SS*7	0.39	34.4	0.19	38.8	35.8	21
COC-4SS*8	0.26	68.8	0.22	26.4	25.8	18
COC-4SS*10	0.8	103	0.22	46.1	34.4	-15
COC-4SS*11	0.48	74	-0.11	35.2	44.6	19

Appendix B

Geochemical metal concentrations for
unconsolidated material, soil, loess, and till
samples, Crab Orchard, Illinois.
(1/2 detection limits)

Table 1. Geochemical analytical metal concentrations for selected unconsolidated material samples, Crab Orchard, IL. (n=36).

SAMPLE	TYPE	ID	COLL.DATE	COLL.TIME
CO-BACK*1	BCKGND	SSBG-1-3-5	10/03/91	08:45
CO-BACK*2	BCKGND	SSBG-2-0-2	10/03/91	10:00
CO-BACK*3	BCKGND	SSBG-2-3-5	10/03/91	10:13
CO-BACK*5	BCKGND	SSBG-3-3-5	10/03/91	08:45
CO-BACK*4	BCKGND	SSBG-2-7-10	10/03/91	10:50
COC-6MWS*1	LOESS	MWS-COC6-2-5-7	09/30/91	12:15
COC-1MWS*1	LOESS	MWSCOC1-1-5-7	09/25/91	07:55
COC-2MWS*1	LOESS	MWS-COC2-1-5-7	10/01/91	
COC-9MWS*2	LOESS	MWS-COC9-2-12-14	09/25/91	09:45
COC-9MWS*1	LOESS	MWS-COC9-2-5-7	09/25/91	08:50
COC-1MWS*2	LOESS	MWSCOC1-1-12-14	09/25/91	08:25
COC-6MWS*2	LOESS	MWS-COC6-2-5-7	09/30/91	12:15
COC-5MWS*1	LOESS	MWSCOC5-1-5-7	09/30/91	12:25
COC-6MWS*3	TILL	MWS-COC6-2-12-14	09/30/91	15:30
COC-4MWS*1	TILL	MWSCOC4-1-5-7	09/23/91	12:54
COC-1MWS*3	TILL	MWSCOC1-1-19-21	09/25/91	09:38
COC-2MWS*2	TILL	MWS-COC2-1-12-14	10/01/91	16:00
COC-9*20	SOIL	TPCOC9-3-4-6	08/23/91	08:48
COP-4*17	SOIL	TPCOP4-3-8-10	08/28/91	10:22
COP-4*26	SOIL	TPCOP4-2-4-6	08/27/91	15:15
COP-4*16	SOIL	TPCOP4-7-0-2	09/04/91	10:40
COC-5*10	SOIL	TPCOC5-1-4-6	08/22/91	09:22
COC-5*9	SOIL	TPCOC5-2-4-6	08/22/91	10:58
COC-7*6	SOIL	TPCOC7-2-4-6	08/26/91	16:32
COP-4*25	SOIL	TPCOP4-5-6-8	09/03/91	14:40
COC-4SS*1	SS4	SSCOC4-1	09/08/91	09:35
COC-4SS*2	SS4	SSCOC4-2	09/08/91	09:35
COC-4SS*3	SS4	SSCOC4-3	09/08/91	10:15
COC-4SS*9	SS4	SSCOC4-9	09/11/91	09:25
COC-4SS*4	SS4	SSCOC4-4	09/08/91	10:45
COC-4SS*5	SS4	SSCOC4-5	09/08/91	12:10
COC-4SS*6	SS4	SSCOC4-6	09/08/91	12:45
COC-4SS*7	SS4	SSCOC4-7	09/08/91	13:40
COC-4SS*8	SS4	SSCOC4-8	09/08/91	14:20
COC-4SS*10	SS4	SSCOC4-10	09/11/91	09:55
COC-4SS*11	SS4	SSCOC4-11	09/11/91	10:25

BCKGND = background sample.

SSBG = Soil sample, background.

MWS = monitoring well sample.

TP = test pit sample.

SS = surface soil sample.

Table 1. (Cont.)

SAMPLE	PARLIST	STOR*METH 1105*SCLPS 1097*SCLPS 1002*SCLPS			
		PARAMETER NAME	ALUMINUM	ANTIMONY	ARSENIC
CO-BACK*1	CO-9	CONC MG/KG-DRY	14900	0.73	8.02
CO-BACK*2	CO-9	CONC MG/KG-DRY	9690	0.695	2.99
CO-BACK*3	CO-9	CONC MG/KG-DRY	28700	0.740	6.18
CO-BACK*5	CO-9	CONC MG/KG-DRY	12300	0.775	8.02
CO-BACK*4	CO-2	CONC MG/KG-DRY	9400	0.770	2.75
COC-6MWS*1	CO-1	CONC MG/KG-DRY	11300	0.665	3.21
COC-1MWS*1	CO-1	CONC MG/KG-DRY	8740	0.670	5.68
COC-2MWS*1		CONC MG/KG-DRY	9140	0.690	3.16
COC-9MWS*2	CO-1	CONC MG/KG-DRY	25600	0.705	5.10
COC-9MWS*1	CO-1	CONC MG/KG-DRY	10400	0.690	4.03
COC-1MWS*2	CO-1	CONC MG/KG-DRY	10200	0.725	5.97
COC-6MWS*2	CO-1	CONC MG/KG-DRY	11300	0.660	2.51
COC-5MWS*1	CO-1	CONC MG/KG-DRY	10500	0.720	2.58
COC-6MWS*3	CO-1	CONC MG/KG-DRY	19000	0.695	28.00
COC-4MWS*1	CO-1	CONC MG/KG-DRY	10700	0.710	4.34
COC-1MWS*3	CO-1	CONC MG/KG-DRY	11700	1.690	6.49
COC-2MWS*2		CONC MG/KG-DRY	11200	0.745	4.61
COC-9*20	CO-2	CONC MG/KG-DRY	17400	0.805	15.50
COP-4*17	CO-3	CONC MG/KG-DRY	7340	0.705	4.21
COP-4*26	CO-1	CONC MG/KG-DRY	10500	0.640	3.79
COP-4*16	CO-1	CONC MG/KG-DRY	19700	0.685	4.03
COC-5*10	CO-2	CONC MG/KG-DRY	20500	0.715	5.34
COC-5*9	CO-2	CONC MG/KG-DRY	15000	0.645	2.86
COC-7*6	CO-2	CONC MG/KG-DRY	17300	0.680	2.62
COP-4*25	CO-3	CONC MG/KG-DRY	13000	0.715	1.76
COC-4SS*1	CO-3	CONC MG/KG-DRY	9650	1.800	7.87
COC-4SS*2	CO-3	CONC MG/KG-DRY	12600	0.735	10.70
COC-4SS*3	CO-3	CONC MG/KG-DRY	10500	2.190	6.79
COC-4SS*9	CO-3	CONC MG/KG-DRY	15300	0.695	3.81
COC-4SS*4	CO-1	CONC MG/KG-DRY	8970	1.830	3.65
COC-4SS*5	CO-1	CONC MG/KG-DRY	9370	0.710	4.08
COC-4SS*6	CO-1	CONC MG/KG-DRY	14400	2.410	7.22
COC-4SS*7	CO-1	CONC MG/KG-DRY	10600	0.670	6.15
COC-4SS*8	CO-1	CONC MG/KG-DRY	8650	1.490	7.21
COC-4SS*10	CO-1	CONC MG/KG-DRY	14600	0.740	8.48
COC-4SS*11	CO-1	CONC MG/KG-DRY	15800	0.750	3.65
AVERAGE			13221	0.908	5.93
MAXIMUM			28700	2.410	28.00
MINIMUM			7340	0.640	1.76
STD			4738	0.463	4.59

Table 1. (Cont.)

SAMPLE	1007*SCLPS BARIUM	1012*SCLPS BERYLLIUM	1027*SCLPS CADMIUM	916*SCLPS CALCIUM	1034*SCLPS CHROMIUM
CO-BACK*1	125.0	0.63	0.115	976	21.2
CO-BACK*2	160.0	0.61	0.105	871	12.9
CO-BACK*3	151.0	0.77	0.115	849	29.8
CO-BACK*5	110.0	0.57	0.120	850	18.7
CO-BACK*4	102.0	0.53	0.120	1040	16.3
COC-6MWS*1	145.0	0.64	0.100	1300	20.8
COC-1MWS*1	131.0	0.70	0.105	1560	16.0
COC-2MWS*1	111.0	0.55	0.105	1420	17.2
COC-9MWS*2	110.0	2.91	0.110	4180	30.7
COC-9MWS*1	160.0	0.66	0.105	1140	20.1
COC-1MWS*2	88.9	0.87	0.110	2200	17.3
COC-6MWS*2	176.0	0.74	0.100	1360	24.5
COC-5MWS*1	147.0	0.59	0.570	1330	17.8
COC-6MWS*3	114.0	1.13	0.105	3280	28.8
COC-4MWS*1	62.9	2.52	3.900	4330	20.5
COC-1MWS*3	144.0	1.73	4.040	17900	32.8
COC-2MWS*2	77.3	1.55	0.115	2530	17.0
COC-9*20	77.3	0.86	1.350	913	31.1
COP-4*17	82.1	0.50	0.110	2010	8.9
COP-4*26	61.4	0.43	0.100	2250	10.8
COP-4*16	59.2	0.51	0.105	1120	23.1
COC-5*10	147.0	0.66	0.370	1330	22.3
COC-5*9	124.0	0.65	0.250	1400	18.8
COC-7*6	72.5	0.64	0.105	1770	27.4
COP-4*25	84.7	0.60	0.110	1930	15.5
COC-4SS*1	84.7	0.68	0.700	747	16.3
COC-4SS*2	110.0	0.81	0.750	859	25.7
COC-4SS*3	87.3	0.54	0.110	1080	14.2
COC-4SS*9	129.0	0.74	0.105	1610	22.3
COC-4SS*4	134.0	0.55	0.110	778	17.7
COC-4SS*5	83.5	0.61	0.380	645	14.1
COC-4SS*6	113.0	0.62	0.430	1180	19.8
COC-4SS*7	103.0	0.78	0.105	919	21.0
COC-4SS*8	102.0	0.58	0.105	903	15.2
COC-4SS*10	122.0	0.82	0.115	1350	42.9
COC-4SS*11	116.0	0.60	0.115	1320	20.1
Average	111.3	0.83	0.432	1979	20.8
Maximum	176.0	2.91	4.040	17900	42.9
Minimum	59.2	0.43	0.100	645	8.9
STD	30.1	0.53	0.895	2826	6.8

Table 1. (Cont.)

SAMPLE	1037*SCLPS	1042*SCLPS	1018*SCLPS	1051*SCLPS	927*SCLPS
	COBALT	COPPER	IRON	LEAD	MAGNESIUM
CO-BACK*1	11.70	19.2	23000	18.00	3180
CO-BACK*2	11.10	14.7	13500	18.80	1520
CO-BACK*3	8.09	21.1	28000	14.40	4120
CO-BACK*5	9.87	18.0	21500	18.70	2740
CO-BACK*4	8.79	10.4	13800	9.53	1650
COC-6MWS*1	9.20	10.9	17100	13.20	2220
COC-1MWS*1	9.01	12.9	16500	10.30	2120
COC-2MWS*1	6.38	11.5	16300	12.00	2090
COC-9MWS*2	130.00	22.9	37000	32.10	3410
COC-9MWS*1	10.60	11.5	16500	12.50	2190
COC-1MWS*2	39.90	13.6	26700	19.60	1650
COC-6MWS*2	12.00	12.8	19600	12.00	2290
COC-5MWS*1	8.10	11.9	15100	10.90	2060
COC-6MWS*3	12.80	21.1	28000	19.20	4430
COC-4MWS*1	49.00	24.7	60200	11.70	3480
COC-1MWS*3	18.60	49.9	46500	21.40	6590
COC-2MWS*2	17.90	16.2	23500	15.50	2980
COC-9*20	12.70	17.2	22500	18.60	2340
COP-4*17	3.66	6.0	8410	11.50	1130
COP-4*26	3.99	6.6	10100	7.73	1320
COP-4*16	5.02	12.0	18900	14.60	2110
COC-5*10	10.40	17.7	23200	18.00	2800
COC-5*9	7.58	9.1	18300	10.50	1950
COC-7*6	7.18	12.6	21600	15.00	1970
COP-4*25	4.76	8.0	13600	9.75	1660
COC-4SS*1	13.20	11.1	22900	13.80	1360
COC-4SS*2	10.80	13.9	27900	13.70	1730
COC-4SS*3	7.40	10.0	14900	11.30	1560
COC-4SS*9	10.80	15.8	23300	16.20	2470
COC-4SS*4	8.71	9.3	14000	11.60	1260
COC-4SS*5	12.10	10.1	23100	12.20	1330
COC-4SS*6	8.55	16.3	20500	15.70	2470
COC-4SS*7	17.70	13.4	27800	19.50	1610
COC-4SS*8	11.00	10.1	16700	13.60	1430
COC-4SS*10	18.60	13.2	30800	19.00	1820
COC-4SS*11	8.16	12.4	19600	13.90	2240
Average	15.43	14.7	22248	14.89	2313
Maximum	130.00	49.9	60200	32.10	6590
Minimum	3.66	6.0	8410	7.73	1130
STD	21.24	7.4	9735	4.50	1060

Table 1. (Cont.)

SAMPLE	1055*SCLPS	71900*SCLPS	1067*SCLPS	937*SCLPS	1147*SCLPS
	MANGANESE	MERCURY	NICKEL	POTASSIUM	SELENIUM
CO-BACK*1	442	0.04700	19.60	890	0.46
CO-BACK*2	1340	0.04625	16.20	616	0.36
CO-BACK*3	237	0.04895	23.40	1590	0.10
CO-BACK*5	396	0.04605	17.70	462	0.48
CO-BACK*4	348	0.04205	14.30	201	0.11
COC-6MWS*1	519	0.04980	16.80	383	0.93
COC-1MWS*1	478	0.04805	17.00	466	0.30
COC-2MWS*1	313	0.04445	17.90	240	0.10
COC-9MWS*2	787	0.03135	40.20	1370	0.24
COC-9MWS*1	411	0.03610	16.30	537	0.26
COC-1MWS*2	986	0.04340	19.00	436	0.34
COC-6MWS*2	408	0.04125	16.10	394	0.11
COC-5MWS*1	610	0.03395	17.00	254	0.35
COC-6MWS*3	275	0.05600	26.10	1750	0.11
COC-4MWS*1	1620	0.05650	62.10	930	0.70
COC-1MWS*3	632	0.05350	40.40	1240	1.37
COC-2MWS*2	577	0.05500	33.20	397	0.10
COC-9*20	308	0.05200	34.80	838	1.50
COP-4*17	231	0.04525	6.51	130	0.00
COP-4*26	303	0.04590	7.58	374	0.11
COP-4*16	116	0.05700	11.20	921	0.00
COC-5*10	473	0.04710	18.00	1490	0.44
COC-5*9	350	0.04195	16.20	732	0.11
COC-7*6	154	0.05400	14.60	730	0.29
COP-4*25	467	0.04325	9.01	659	0.10
COC-4SS*1	837	0.03390	13.10	386	0.41
COC-4SS*2	644	0.03985	16.50	479	0.45
COC-4SS*3	386	0.05150	12.50	433	0.37
COC-4SS*9	403	0.04665	19.10	816	0.21
COC-4SS*4	659	0.04460	11.60	436	0.45
COC-4SS*5	567	0.04580	15.30	362	0.24
COC-4SS*6	327	0.04130	16.00	852	0.45
COC-4SS*7	907	0.04465	12.20	328	0.52
COC-4SS*8	763	0.05250	9.55	247	0.72
COC-4SS*10	956	0.04515	16.30	676	0.27
COC-4SS*11	262	0.05000	15.70	939	0.29
Average	541	0.04617	19.14	666	0.37
Maximum	1620	0.05700	62.10	1750	1.50
Minimum	116	0.03135	6.51	130	0.00
STD	317	0.00630	10.72	402	0.33

Table 1. (Cont.)

SAMPLE	1077*SCLPS SILVER	929*SCLPS SODIUM	1059*SCLPS THALLIUM	1087*SCLPS VANADIUM	1092*SCLPS ZINC
CO-BACK*1	0.69	173.0	0.37	33.2	58.1
CO-BACK*2	0.51	11.0	0.22	25.1	40.4
CO-BACK*3	0.54	159.0	0.31	55.2	61.3
CO-BACK*5	0.49	166.0	0.31	29.5	55.9
CO-BACK*4	0.45	166.0	0.06	24.3	31.5
COC-6MWS*1	0.52	119.0	0.22	32.5	31.7
COC-1MWS*1	0.46	186.0	0.30	28.2	37.2
COC-2MWS*1	0.53	54.6	0.13	27.6	31.0
COC-9MWS*2	0.99	192.0	0.14	49.5	48.4
COC-9MWS*1	0.54	74.6	0.22	29.7	36.6
COC-1MWS*2	0.85	363.0	0.27	33.6	28.3
COC-6MWS*2	0.51	123.0	0.15	36.7	34.6
COC-5MWS*1	0.60	80.0	0.11	30.4	33.9
COC-6MWS*3	0.70	236.0	0.16	41.7	58.2
COC-4MWS*1	1.00	360.0	0.15	30.8	267.0
COC-1MWS*3	0.93	257.0	1.36	70.8	123.0
COC-2MWS*2	0.56	405.0	0.19	26.9	46.7
COC-9*20	0.58	131.0	0.63	96.0	208.0
COP-4*17	0.26	221.0	0.19	17.3	56.1
COP-4*26	0.25	451.0	0.06	20.8	22.1
COP-4*16	0.64	82.9	0.18	37.3	39.8
COC-5*10	0.38	83.5	0.29	42.9	60.3
COC-5*9	0.27	66.7	0.20	34.4	33.4
COC-7*6	0.50	168.0	0.46	46.4	44.9
COP-4*25	0.31	224.0	0.34	26.9	39.5
COC-4SS*1	0.29	36.2	0.14	28.4	54.1
COC-4SS*2	0.25	34.2	0.15	36.4	54.0
COC-4SS*3	0.11	48.3	0.19	24.1	33.0
COC-4SS*9	0.72	44.1	0.20	38.7	45.6
COC-4SS*4	0.25	98.7	0.24	23.4	37.9
COC-4SS*5	0.38	26.8	0.14	26.8	57.2
COC-4SS*6	0.25	24.9	0.36	34.9	46.4
COC-4SS*7	0.39	34.4	0.19	38.8	35.8
COC-4SS*8	0.26	68.8	0.22	26.4	25.8
COC-4SS*10	0.80	103.0	0.22	46.1	34.4
COC-4SS*11	0.48	74.0	0.06	35.2	44.6
Average	0.51	143.0	0.25	35.7	55.5
Maximum	1.00	451.0	1.36	96.0	267.0
Minimum	0.11	11.0	0.06	17.3	22.1
STD	0.22	111.0	0.22	14.4	47.8

Figure 1. Average metal concentrations for unconsolidated materials, Crab Orchard, Illinois.

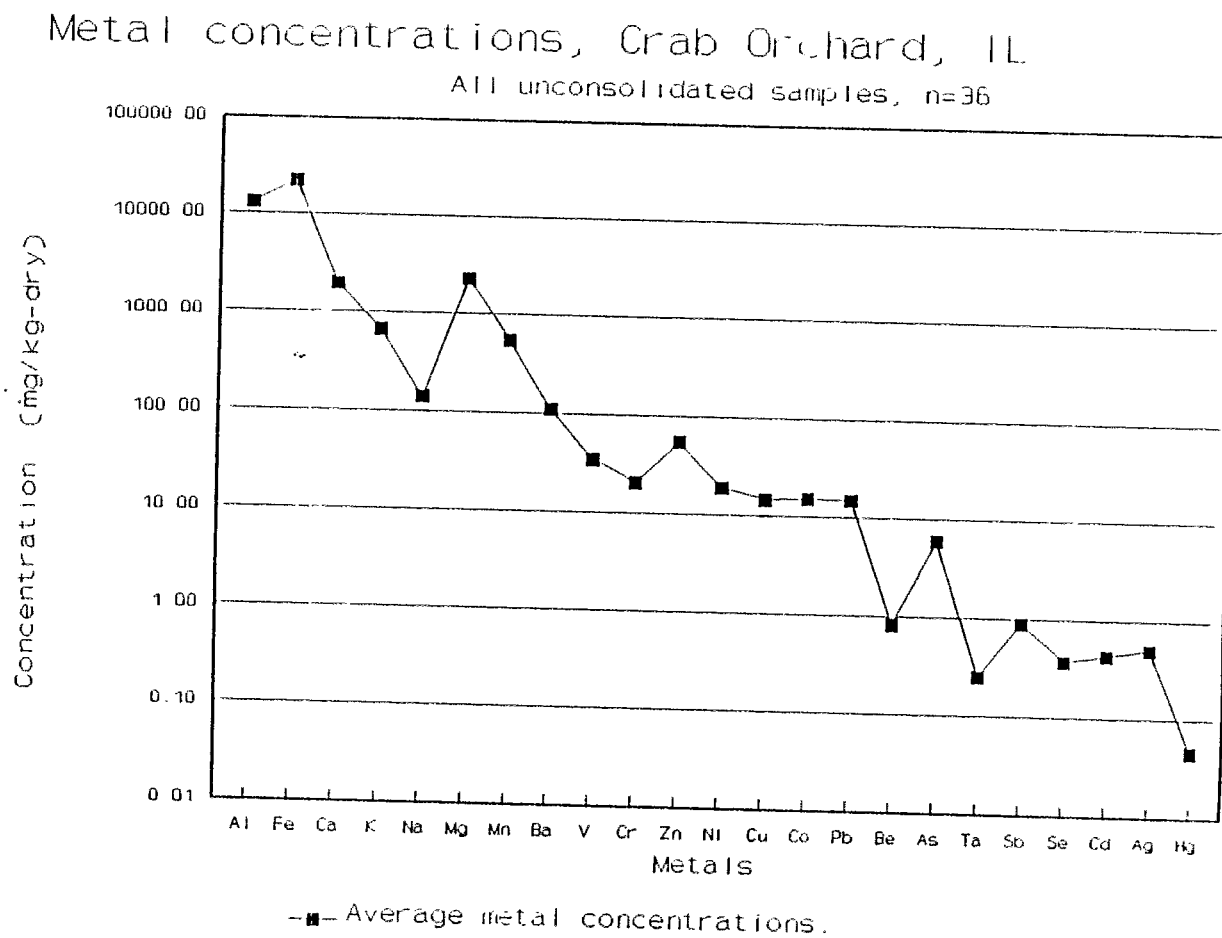


Figure 2. Metal concentrations for unconsolidated materials, Crab Orchard, Illinois.

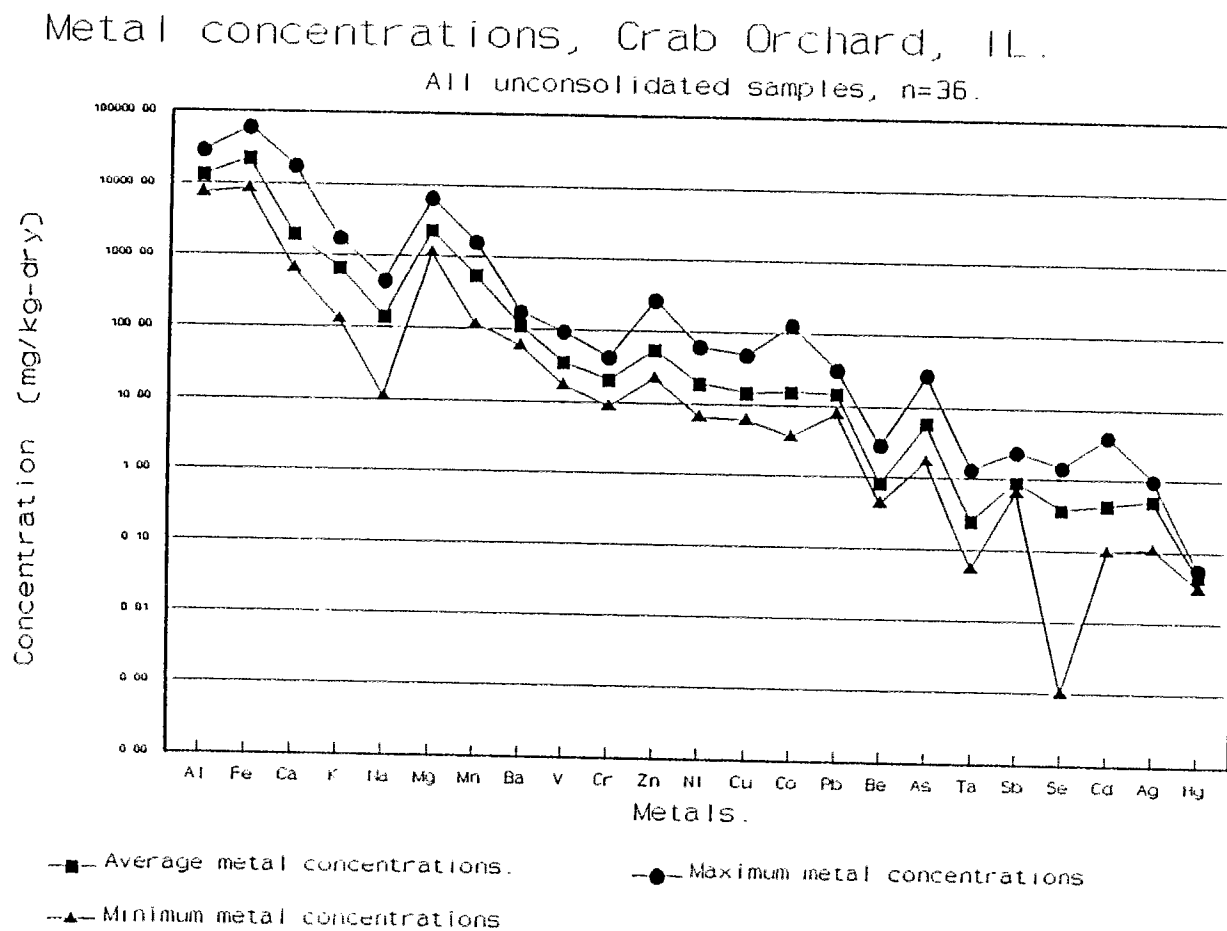


Table 2. Geochemical analytical metal concentrations for selected soil samples, Crab Orchard, Illinois.

SAMPLE	TYPE	ID	COLL.DATE	COLL.TIME	PARLIST
COC-9*20	SOIL	TPCOC9-3-4-6	08/23/91	08:48	CO-2
COP-4*17	SOIL	TPCOP4-3-8-10	08/28/91	10:22	CO-3
COP-4*26	SOIL	TPCOP4-2-4-6	08/27/91	15:15	CO-1
COP-4*16	SOIL	TPCOP4-7-0-2	09/04/91	10:40	CO-1
COC-5*10	SOIL	TPCOC5-1-4-6	08/22/91	09:22	CO-2
COC-5*9	SOIL	TPCOC5-2-4-6	08/22/91	10:58	CO-2
COC-7*6	SOIL	TPCOC7-2-4-6	08/26/91	16:32	CO-2
COP-4*25	SOIL	TPCOP4-5-6-8	09/03/91	14:40	CO-3
CO-BACK*1	BCKGND	SSBG-1-3-5	10/03/91	08:45	CO-9
CO-BACK*2	BCKGND	SSBG-2-0-2	10/03/91	10:00	CO-9
CO-BACK*3	BCKGND	SSBG-2-3-5	10/03/91	10:13	CO-9
CO-BACK*5	BCKGND	SSBG-3-3-5	10/03/91	08:45	CO-9
CO-BACK*4	BCKGND	SSBG-2-7-10	10/03/91	10:50	CO-2
COC-4SS*1	SS-4	SSCOC4-1	09/08/91	09:35	CO-3
COC-4SS*2	SS-4	SSCOC4-2	09/08/91	09:35	CO-3
COC-4SS*3	SS-4	SSCOC4-3	09/08/91	10:15	CO-3
COC-4SS*9	SS-4	SSCOC4-9	09/11/91	09:25	CO-3
COC-4SS*4	SS-4	SSCOC4-4	09/08/91	10:45	CO-1
COC-4SS*5	SS-4	SSCOC4-5	09/08/91	12:10	CO-1
COC-4SS*6	SS-4	SSCOC4-6	09/08/91	12:45	CO-1
COC-4SS*7	SS-4	SSCOC4-7	09/08/91	13:40	CO-1
COC-4SS*8	SS-4	SSCOC4-8	09/08/91	14:20	CO-1
COC-4SS*10	SS-4	SSCOC4-10	09/11/91	09:55	CO-1
COC-4SS*11	SS-4	SSCOC4-11	09/11/91	10:25	CO-1

BCKGND = background samples.

TP = test pit sample.

SSBG = surface soil background sample.

SS = surface soil sample.

Table 2. (Cont.)

SAMPLE	STOR*METH PARAMETER	1105*SCLPS ALUMINUM	1097*SCLPS ANTIMONY	1002*SCLPS ARSENIC	1007*SCLPS BARIUM
COC-9*20	CONC MG/KG DRY	17400	0.805	15.50	77.3
COP-4*17	CONC MG/KG DRY	7340	0.705	4.21	82.1
COP-4*26	CONC MG/KG DRY	10500	0.640	3.79	61.4
COP-4*16	CONC MG/KG DRY	19700	0.685	4.03	59.2
COC-5*10	CONC MG/KG DRY	20500	0.715	5.34	147.0
COC-5*9	CONC MG/KG DRY	15000	0.645	2.86	124.0
COC-7*6	CONC MG/KG DRY	17300	0.680	2.62	72.5
COP-4*25	CONC MG/KG DRY	13000	0.715	1.76	84.7
CO-BACK*1	CONC MG/KG DRY	14900	0.735	8.02	125.0
CO-BACK*2	CONC MG/KG DRY	9690	0.695	2.99	160.0
CO-BACK*3	CONC MG/KG DRY	28700	0.740	6.18	151.0
CO-BACK*5	CONC MG/KG DRY	12300	0.775	8.02	110.0
CO-BACK*4	CONC MG/KG DRY	9400	0.770	2.75	102.0
COC-4SS*1	CONC MG/KG DRY	9650	1.800	7.87	84.7
COC-4SS*2	CONC MG/KG DRY	12600	0.735	10.70	110.0
COC-4SS*3	CONC MG/KG DRY	10500	2.190	6.79	87.3
COC-4SS*9	CONC MG/KG DRY	15300	0.695	3.81	129.0
COC-4SS*4	CONC MG/KG DRY	8970	1.830	3.65	134.0
COC-4SS*5	CONC MG/KG DRY	9370	0.710	4.08	83.5
COC-4SS*6	CONC MG/KG DRY	14400	2.410	7.22	113.0
COC-4SS*7	CONC MG/KG DRY	10600	0.670	6.15	103.0
COC-4SS*8	CONC MG/KG DRY	8650	1.490	7.21	102.0
COC-4SS*10	CONC MG/KG DRY	14600	0.740	8.48	122.0
COC-4SS*11	CONC MG/KG DRY	15800	0.750	3.65	116.0
AVERAGE		13590	0.972	5.74	105.9
MAXIMUM		28700	2.410	15.50	160.0
MINIMUM		7340	0.640	1.76	59.2
STD		4729	0.521	3.05	27.0

Table 2.

SAMPLE	1012*SCLPS BERYLLIUM	1027*SCLPS CADMIUM	916*SCLPS CALCIUM	1034*SCLPS CHROMIUM	1037*SCLPS COBALT
COC-9*20	0.86	1.350	913	31.1	12.70
COP-4*17	0.50	0.110	2010	8.9	3.66
COP-4*26	0.43	0.100	2250	10.8	3.99
COP-4*16	0.51	0.105	1120	23.1	5.02
COC-5*10	0.66	0.370	1330	22.3	10.40
COC-5*9	0.65	0.250	1400	18.8	7.58
COC-7*6	0.64	0.105	1770	27.4	7.18
COP-4*25	0.60	0.110	1930	15.5	4.76
CO-BACK*1	0.63	0.115	976	21.2	11.70
CO-BACK*2	0.61	0.105	871	12.9	11.10
CO-BACK*3	0.77	0.115	849	29.8	8.09
CO-BACK*5	0.57	0.120	850	18.7	9.87
CO-BACK*4	0.53	0.120	1040	16.3	8.79
COC-4SS*1	0.68	0.700	747	16.3	13.20
COC-4SS*2	0.81	0.750	859	25.7	10.80
COC-4SS*3	0.54	0.110	1080	14.2	7.40
COC-4SS*9	0.74	0.105	1610	22.3	10.80
COC-4SS*4	0.55	0.110	778	17.7	8.71
COC-4SS*5	0.61	0.380	645	14.1	12.10
COC-4SS*6	0.62	0.430	1180	19.8	8.55
COC-4SS*7	0.78	0.105	919	21.0	17.70
COC-4SS*8	0.58	0.105	903	15.2	11.00
COC-4SS*10	0.82	0.115	1350	42.9	18.60
COC-4SS*11	0.60	0.115	1320	20.1	8.16
Average	0.64	0.254	1196	20.3	9.66
Maximum	0.86	1.350	2250	42.9	18.60
Minimum	0.43	0.100	645	8.9	3.66
STD	0.11	0.293	427	7.2	3.65

Table 2. (Cont.)

SAMPLE	1042*SCLPS COPPER	1018*SCLPS IRON	1051*SCLPS LEAD	927*SCLPS MAGNESIUM	1055*SCLPS MANGANESE
COC-9*20	17.2	22500	18.60	2340	308
COP-4*17	6.0	8410	11.50	1130	231
COP-4*26	6.6	10100	7.73	1320	303
COP-4*16	12.0	18900	14.60	2110	116
COC-5*10	17.7	23200	18.00	2800	473
COC-5*9	9.1	18300	10.50	1950	350
COC-7*6	12.6	21600	15.00	1970	154
COP-4*25	8.0	13600	9.75	1660	467
CO-BACK*1	19.2	23000	18.00	3180	442
CO-BACK*2	14.7	13500	18.80	1520	1340
CO-BACK*3	21.1	28000	14.40	4120	237
CO-BACK*5	18.0	21500	18.70	2740	396
CO-BACK*4	10.4	13800	9.53	1650	348
COC-4SS*1	11.1	22900	13.80	1360	837
COC-4SS*2	13.9	27900	13.70	1730	644
COC-4SS*3	10.0	14900	11.30	1560	386
COC-4SS*9	15.8	23300	16.20	2470	403
COC-4SS*4	9.3	14000	11.60	1260	659
COC-4SS*5	10.1	23100	12.20	1330	567
COC-4SS*6	16.3	20500	15.70	2470	327
COC-4SS*7	13.4	27800	19.50	1610	907
COC-4SS*8	10.1	16700	13.60	1430	763
COC-4SS*10	13.2	30800	19.00	1820	956
COC-4SS*11	12.4	19600	13.90	2240	262
Average	12.8	19913	14.40	1990	495
Maximum	21.1	30800	19.50	4120	1340
Minimum	6.0	8410	7.73	1130	116
STD	3.9	5753	3.36	694	286

Table 2. (Cont.)

SAMPLE	71900*SCLPS	1067*SCLPS	937*SCLPS	1147*SCLPS	1077*SCLPS
	MERCURY	NICKEL	POTASSIUM	SELENIUM	SILVER
COC-9*20	0.05200	34.80	838	1.50	0.58
COP-4*17	0.04525	6.51	130	0.00	0.26
COP-4*26	0.04590	7.58	374	0.11	0.25
COP-4*16	0.05700	11.20	921	0.00	0.64
COC-5*10	0.04710	18.00	1490	0.44	0.38
COC-5*9	0.04195	16.20	732	0.11	0.27
COC-7*6	0.05400	14.60	730	0.29	0.50
COP-4*25	0.04325	9.01	659	0.10	0.31
CO-BACK*1	0.04700	19.60	890	0.46	0.69
CO-BACK*2	0.04625	16.20	616	0.36	0.51
CO-BACK*3	0.04895	23.40	1590	0.10	0.54
CO-BACK*5	0.04605	17.70	462	0.48	0.49
CO-BACK*4	0.04205	14.30	201	0.11	0.45
COC-4SS*1	0.03390	13.10	386	0.41	0.29
COC-4SS*2	0.03985	16.50	479	0.45	0.25
COC-4SS*3	0.05150	12.50	433	0.37	0.11
COC-4SS*9	0.04665	19.10	816	0.21	0.72
COC-4SS*4	0.04460	11.60	436	0.45	0.25
COC-4SS*5	0.04580	15.30	362	0.24	0.38
COC-4SS*6	0.04130	16.00	852	0.45	0.25
COC-4SS*7	0.04465	12.20	328	0.52	0.39
COC-4SS*8	0.05250	9.55	247	0.72	0.26
COC-4SS*10	0.04515	16.30	676	0.27	0.80
COC-4SS*11	0.05000	15.70	939	0.29	0.48
Average	0.04636	15.29	649	0.35	0.42
Maximum	0.05700	34.80	1590	1.50	0.80
Minimum	0.03390	6.51	130	0.00	0.11
STD	0.00487	5.63	356	0.30	0.18

Table 2. (Cont.)

SAMPLE	929*SCLPS SODIUM	1059*SCLPS THALLIUM	1087*SCLPS VANADIUM	1092*SCLPS ZINC
COC-9*20	131.0	0.63	96.0	208.0
COP-4*17	221.0	0.19	17.3	56.1
COP-4*26	451.0	0.06	20.8	22.1
COP-4*16	82.9	0.18	37.3	39.8
COC-5*10	83.5	0.29	42.9	60.3
COC-5*9	66.7	0.20	34.4	33.4
COC-7*6	168.0	0.46	46.4	44.9
COP-4*25	224.0	0.34	26.9	39.5
CO-BACK*1	173.0	0.37	33.2	58.1
CO-BACK*2	11.0	0.22	25.1	40.4
CO-BACK*3	159.0	0.31	55.2	61.3
CO-BACK*5	166.0	0.31	29.5	55.9
CO-BACK*4	166.0	0.06	24.3	31.5
COC-4SS*1	36.2	0.14	28.4	54.1
COC-4SS*2	34.2	0.15	36.4	54.0
COC-4SS*3	48.3	0.19	24.1	33.0
COC-4SS*9	44.1	0.20	38.7	45.6
COC-4SS*4	98.7	0.24	23.4	37.9
COC-4SS*5	26.8	0.14	26.8	57.2
COC-4SS*6	24.9	0.36	34.9	46.4
COC-4SS*7	34.4	0.19	38.8	35.8
COC-4SS*8	68.8	0.22	26.4	25.8
COC-4SS*10	103.0	0.22	46.1	34.4
COC-4SS*11	74.0	0.06	35.2	44.6
Average	112.4	0.24	35.4	50.8
Maximum	451.0	0.63	96.0	208.0
Minimum	11.0	0.06	17.3	22.1
STD	94.3	0.13	15.5	34.6

Figure 3. Average metal concentrations for soil samples, Crab Orchard, Illinois.

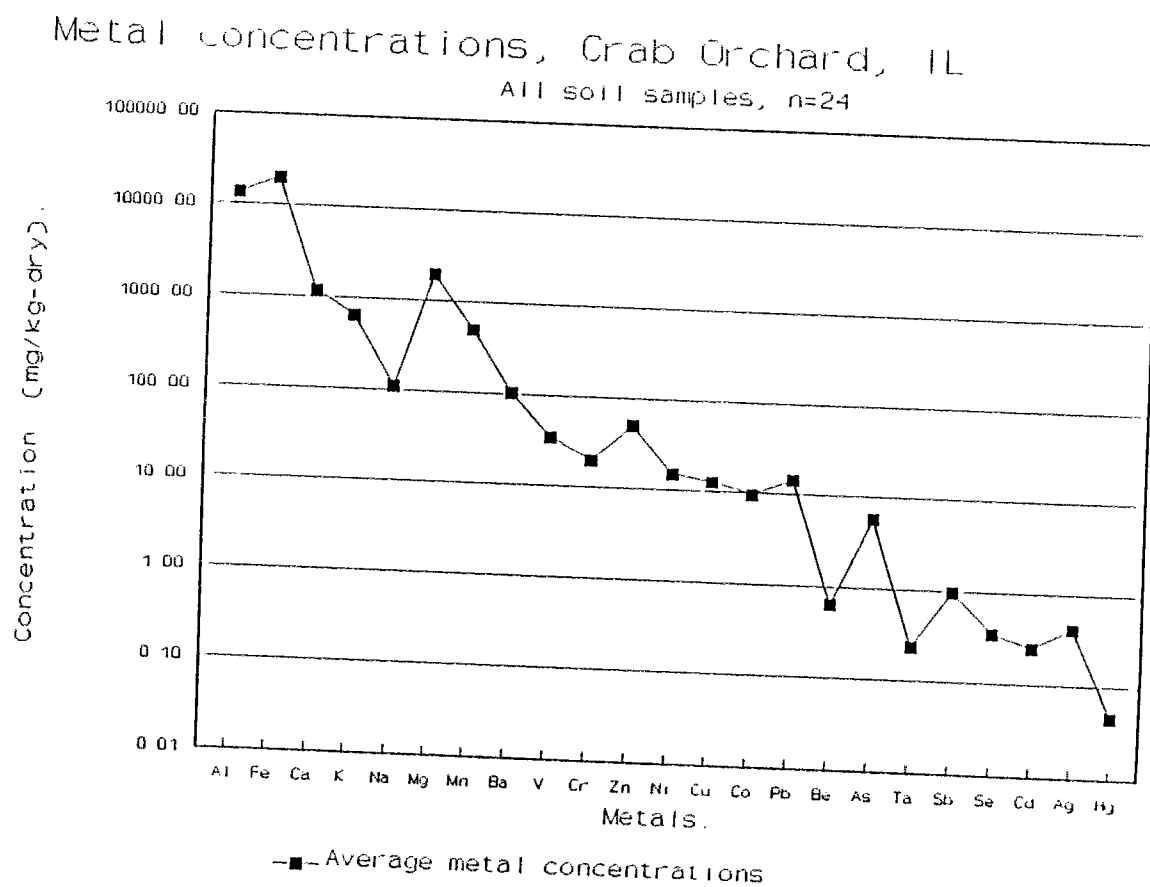


Figure 4. Metal concentrations for soil samples, Crab Orchard, Illinois.

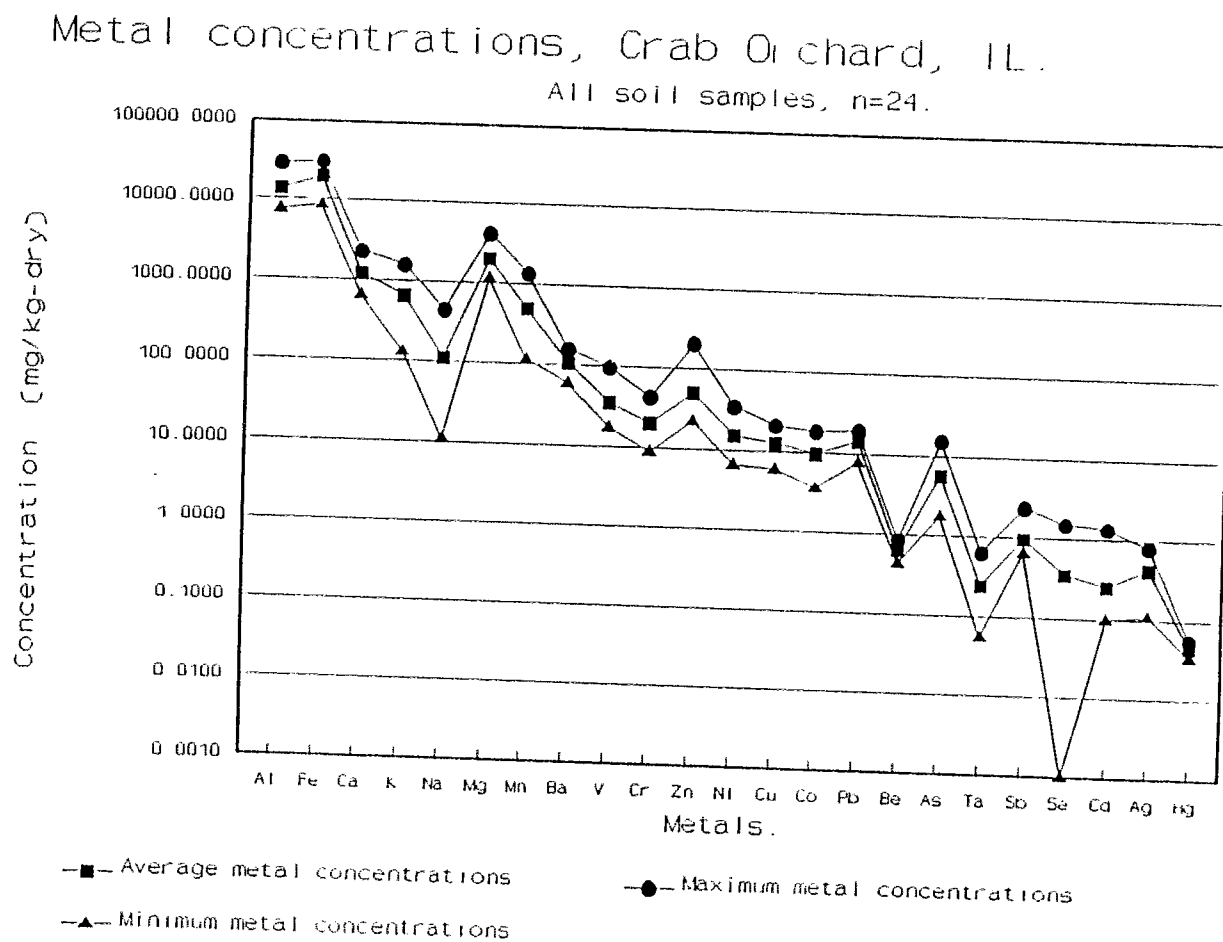


Table 3. Geochemical analytical metal concentrations for selected loess samples, Crab Orchard, Illinois.

SAMPLE	ID	DATE	TIME	PAR
COC-6MWS*1	MWS-COC6-2-5-7	09/30/91	12:15	CO-1
COC-1MWS*1	MWSCOC1-1-5-7	09/25/91	07:55	CO-1
COC-2MWS*1	MWS-COC2-1-5-7	10/01/91		
COC-9MWS*2	MWS-COC9-2-12-14	09/25/91	09:45	CO-1
COC-9MWS*1	MWS-COC9-2-5-7	09/25/91	08:50	CO-1
COC-1MWS*2	MWSCOC1-1-12-14	09/25/91	08:25	CO-1
COC-6MWS*2	MWS-COC6-2-5-7	09/30/91	12:15	CO-1
COC-5MWS*1	MWSCOC5-1-5-7	09/30/91	12:25	CO-1

MWS= monitoring well sample.

Table 3. (Cont.)

SAMPLE	STOR*METH PARAMETER	1105*SCLPS ALUMINUM	1097*SCLPS ANTIMONY	1002*SCLPS ARSENIC
COC-6MWS*1	CONC MG/KG DRY	11300	0.665	3.21
COC-1MWS*1	CONC MG/KG DRY	8740	0.670	5.68
COC-2MWS*1	CONC MG/KG DRY	9140	0.690	3.16
COC-9MWS*2	CONC MG/KG DRY	25600	0.705	5.10
COC-9MWS*1	CONC MG/KG DRY	10400	0.690	4.03
COC-1MWS*2	CONC MG/KG DRY	10200	0.725	5.97
COC-6MWS*2	CONC MG/KG DRY	11300	0.660	2.51
COC-5MWS*1	CONC MG/KG DRY	10500	0.720	2.58
	Average	12148	0.691	4.03
	Maximum	25600	0.725	5.97
	Minimum	8740	0.660	2.51
	STD	5155	0.023	1.30

Table 3. (Cont.)

SAMPLE	1007*SCLPS BARIUM	1012*SCLPS BERYLLIUM	1027*SCLPS CADMIUM	916*SCLPS CALCIUM
COC-6MWS*1	145.0	0.64	0.100	1300
COC-1MWS*1	131.0	0.70	0.105	1560
COC-2MWS*1	111.0	0.55	0.105	1420
COC-9MWS*2	110.0	2.91	0.110	4180
COC-9MWS*1	160.0	0.66	0.105	1140
COC-1MWS*2	88.9	0.87	0.110	2200
COC-6MWS*2	176.0	0.74	0.100	1360
COC-5MWS*1	147.0	0.59	0.570	1330
Average	133.6	0.96	0.163	1811
Maximum	176.0	2.91	0.570	4180
Minimum	88.9	0.55	0.100	1140
STD	27.1	0.74	0.154	944

Table 3. (Cont.)

SAMPLE	1034*SCLPS CHROMIUM	1037*SCLPS COBALT	1042*SCLPS COPPER	1018*SCLPS IRON
COC-6MWS*1	20.8	9.20	10.9	17100
COC-1MWS*1	16.0	9.01	12.9	16500
COC-2MWS*1	17.2	6.38	11.5	16300
COC-9MWS*2	30.7	130.00	22.9	37000
COC-9MWS*1	20.1	10.60	11.5	16500
COC-1MWS*2	17.3	39.90	13.6	26700
COC-6MWS*2	24.5	12.00	12.8	19600
COC-5MWS*1	17.8	8.10	11.9	15100
Average	20.6	28.15	13.5	20600
Maximum	30.7	130.00	22.9	37000
Minimum	16.0	6.38	10.9	15100
STD	4.6	39.81	3.6	7087

Table 3. (Cont.)

SAMPLE	1051*SCLPS LEAD	927*SCLPS MAGNESIUM	1055*SCLPS MANGANESE	71900*SCLPS MERCURY
COC-6MWS*1	13.20	2220	519	0.04980
COC-1MWS*1	10.30	2120	478	0.04805
COC-2MWS*1	12.00	2090	313	0.04445
COC-9MWS*2	32.10	3410	787	0.03135
COC-9MWS*1	12.50	2190	411	0.03610
COC-1MWS*2	19.60	1650	986	0.04340
COC-6MWS*2	12.00	2290	408	0.04125
COC-5MWS*1	10.90	2060	610	0.03395
Average	15.33	2254	564	0.04104
Maximum	32.10	3410	986	0.04980
Minimum	10.30	1650	313	0.03135
STD	6.88	473	209	0.00624

Table 3. (Cont.)

SAMPLE	1067*SCLPS NICKEL	937*SCLPS POTASSIUM	1147*SCLPS SELENIUM	1077*SCLPS SILVER
COC-6MWS*1	16.80	383	0.93	0.52
COC-1MWS*1	17.00	466	0.30	0.46
COC-2MWS*1	17.90	240	0.10	0.53
COC-9MWS*2	40.20	1370	0.24	0.99
COC-9MWS*1	16.30	537	0.26	0.54
COC-1MWS*2	19.00	436	0.34	0.85
COC-6MWS*2	16.10	394	0.11	0.51
COC-5MWS*1	17.00	254	0.35	0.60
Average	20.04	510	0.33	0.63
Maximum	40.20	1370	0.93	0.99
Minimum	16.10	240	0.10	0.46
STD	7.67	338	0.24	0.18

Table 3. (Cont.)

SAMPLE	929*SCLPS SODIUM	1059*SCLPS THALLIUM	1087*SCLPS VANADIUM	1092*SCLPS ZINC
COC-6MWS*1	119.0	0.22	32.5	31.7
COC-1MWS*1	186.0	0.30	28.2	37.2
COC-2MWS*1	54.6	0.13	27.6	31.0
COC-9MWS*2	192.0	0.14	49.5	48.4
COC-9MWS*1	74.6	0.22	29.7	36.6
COC-1MWS*2	363.0	0.27	33.6	28.3
COC-6MWS*2	123.0	0.15	36.7	34.6
COC-5MWS*1	80.0	0.11	30.4	33.9
Average	149.0	0.19	33.5	35.2
Maximum	363.0	0.30	49.5	48.4
Minimum	54.6	0.11	27.6	28.3
STD	93.4	0.07	6.7	5.7

Figure 5. Average metal concentrations in loess samples, Crab Orchard, Illinois.

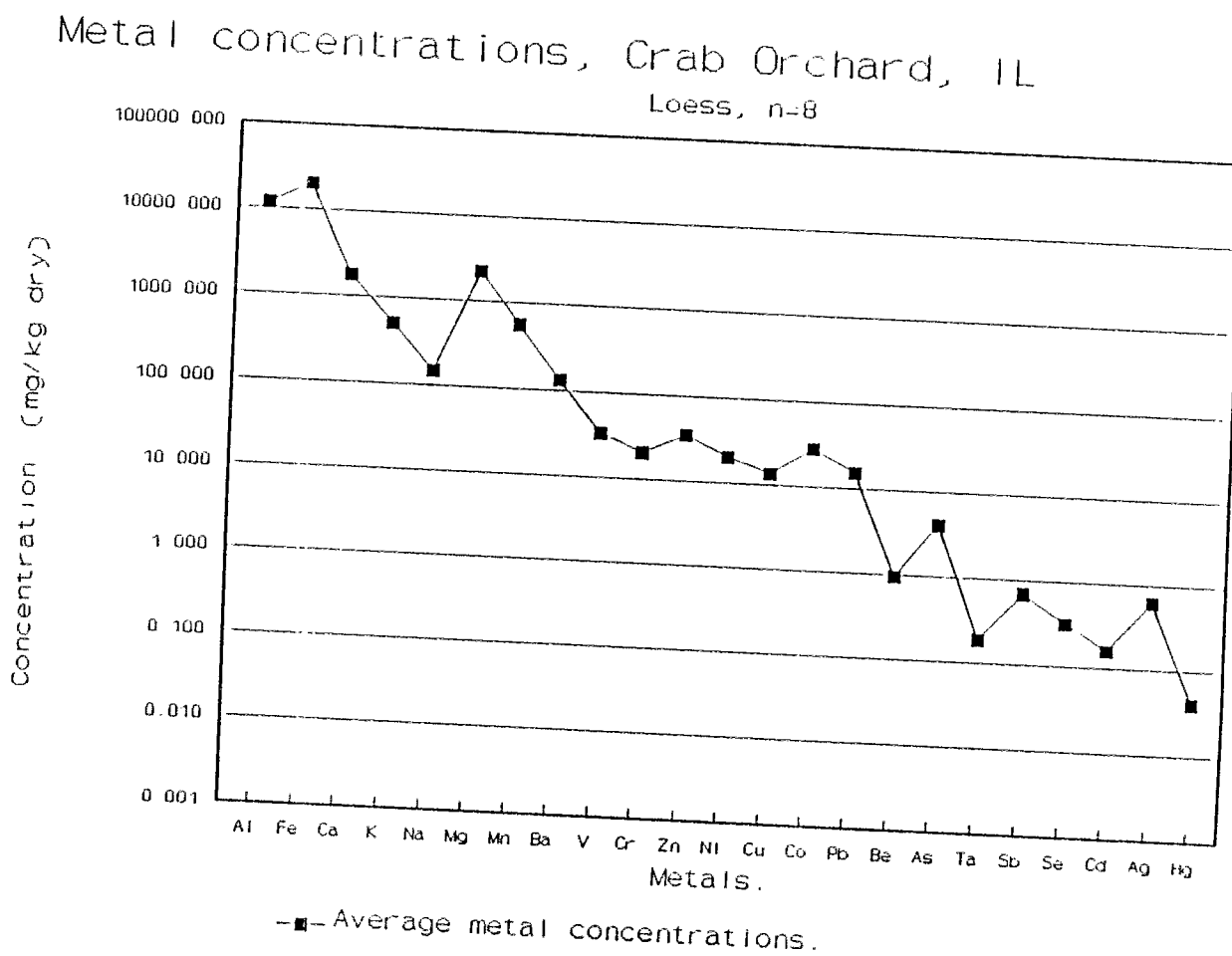


Figure 6. Metal concentrations in loess samples, Crab Orchard, Illinois.

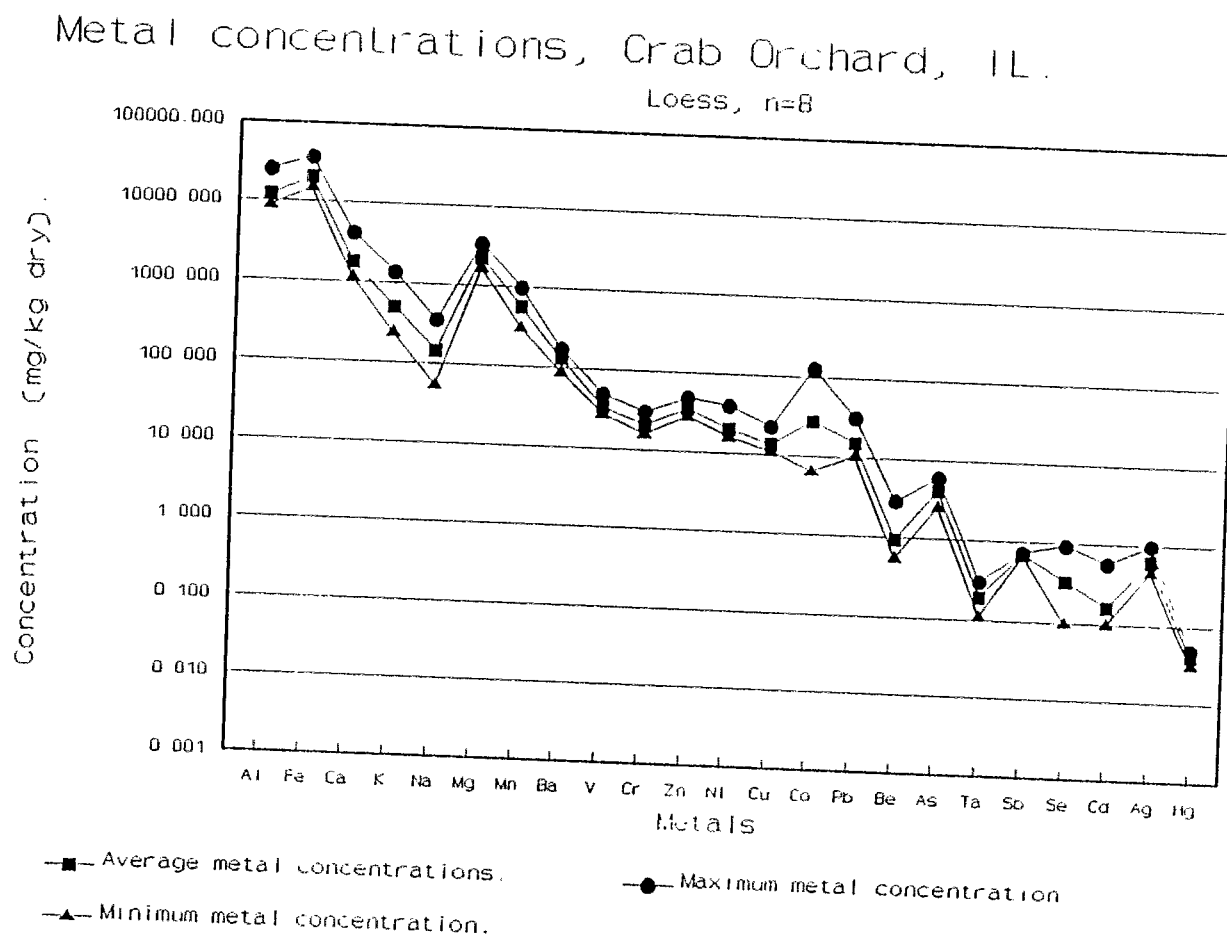


Table 4. Geochemical analytical material concentrations for till samples, Crab Orchard, Illinois.

SAMPLE	ID	COLL.DATE	COLL.TIME	PARLIST
COC-6MWS*3	MWS-COC6-2-12-14	09/30/91	15:30	CO-1
COC-4MWS*1	MWSCOC4-1-5-7	09/23/91	12:54	CO-1
COC-1MWS*3	MWSCOC1-1-19-21	09/25/91	09:38	CO-1
COC-2MWS*2	MWS-COC2-1-12-14	10/01/91	16:00	

MWS = monitoring well sample.

Table 4. (Cont.)

SAMPLE	STOR*METH PARAMETER NAME	1105*SCLPS ALUMINUM	1097*SCLPS ANTIMONY	1002*SCLPS ARSENIC
COC-6MWS*3	CONC MG/KG DRY	19000	0.695	28.00
COC-4MWS*1	CONC MG/KG DRY	10700	0.710	4.34
COC-1MWS*3	CONC MG/KG DRY	11700	1.690	6.49
COC-2MWS*2	CONC MG/KG DRY	11200	0.745	4.61
	Average	11174	3.128	14.83
	Maximum	19000	11.800	30.70
	Minimum	10700	0.695	4.34
	STD	3396	0.422	9.93

Table 4. (Cont.)

SAMPLE	1012*SCLPS BERYLLIUM	1027*SCLPS CADMIUM	916*SCLPS CALCIUM	1034*SCLPS CHROMIUM	1007*SCLPS BARIUM
COC-6MWS*3	1.13	0.105	3280	28.8	114.0
COC-4MWS*1	2.52	3.900	4330	20.5	62.9
COC-1MWS*3	1.73	4.040	17900	32.8	144.0
COC-2MWS*2	1.55	0.115	2530	17.0	77.3
Average	1.41	4.112	6106	28.6	103.8
Maximum	2.52	12.400	17900	43.7	144.0
Minimum	1.13	0.105	2530	17.0	62.9
STD	0.50	1.931	6320	6.3	31.7

Table 4. (Cont.)

SAMPLE	1042*SCLPS	1018*SCLPS	1051*SCLPS	927*SCLPS	1037*SCLPS
	COPPER	IRON	LEAD	MAGNESIUM	COBALT
COC-6MWS*3	21.1	28000	19.20	4430	12.80
COC-4MWS*1	24.7	60200	11.70	3480	49.00
COC-1MWS*3	49.9	46500	21.40	6590	18.60
COC-2MWS*2	16.2	23500	15.50	2980	17.90
Average	39.0	41280	18.04	3554	20.52
Maximum	83.1	60200	22.40	6590	49.00
Minimum	16.2	23500	11.70	2980	12.80
STD	13.0	14712	3.69	1383	14.28

Table 4. (Cont.)

SAMPLE	71900*SCLPS	1067*SCLPS	937*SCLPS	1147*SCLPS	1055*SCLPS
	MERCURY	NICKEL	POTASSIUM	SELENIUM	MANGANESE
COC-6MWS*3	0.05600	26.10	1750	0.11	275
COC-4MWS*1	0.05650	62.10	930	0.70	1620
COC-1MWS*3	0.05350	40.40	1240	1.37	632
COC-2MWS*2	0.05500	33.20	397	0.10	577
Average	0.08440	43.76	1555	21.26	625
Maximum	0.20100	62.10	3460	104.00	1620
Minimum	0.05350	26.10	397	0.10	275
STD	0.00115	13.48	491	0.52	506

Table 4. (Cont.)

SAMPLE	1059*SCLPS	1087*SCLPS	1092*SCLPS
	THALLIUM	VANADIUM	ZINC
COC-6MWS*3	0.16	41.7	58.2
COC-4MWS*1	0.15	30.8	267.0
COC-1MWS*3	1.36	70.8	123.0
COC-2MWS*2	0.19	26.9	46.7
Average	2.31	122.2	124.4
Maximum	9.71	441.0	267.0
Minimum	0.15	26.9	46.7
STD	0.52	17.2	87.7

Figure 7. Average metal concentrations in till samples, Crab Orchard, Illinois.

Metal concentrations, Crab Orchard, IL. Till samples, n=4.

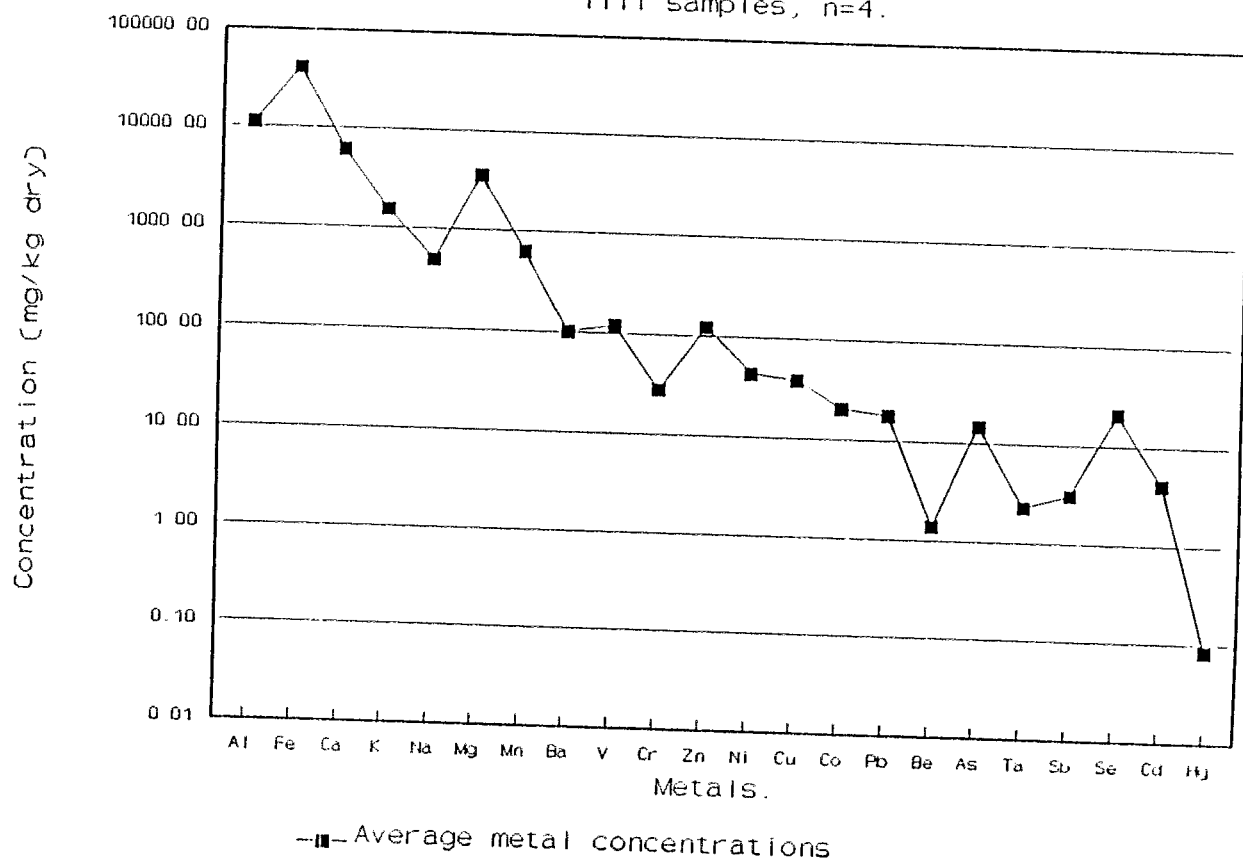


Figure 8. Metal concentrations in till samples, Crab Orchard Illinois.

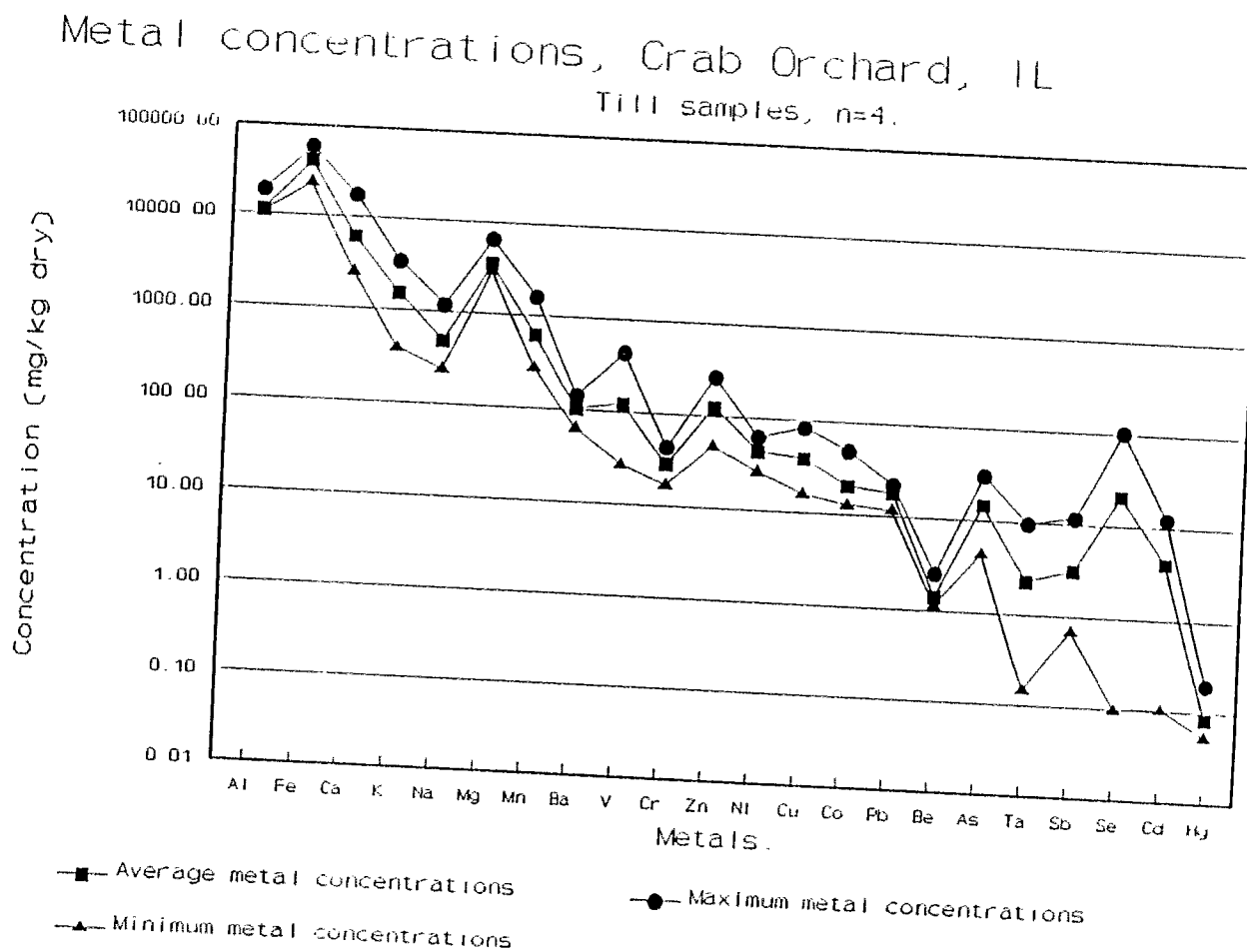


Figure 9.

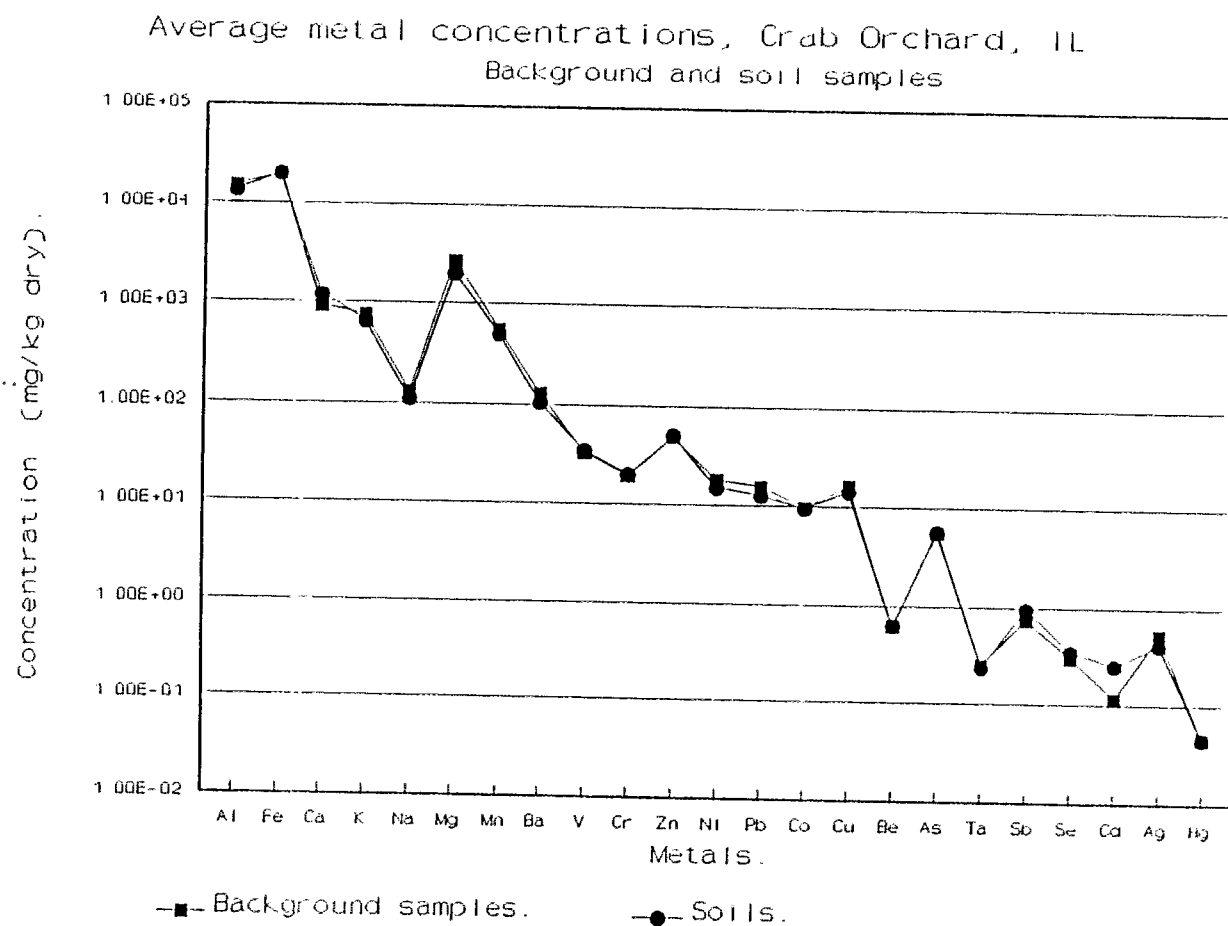
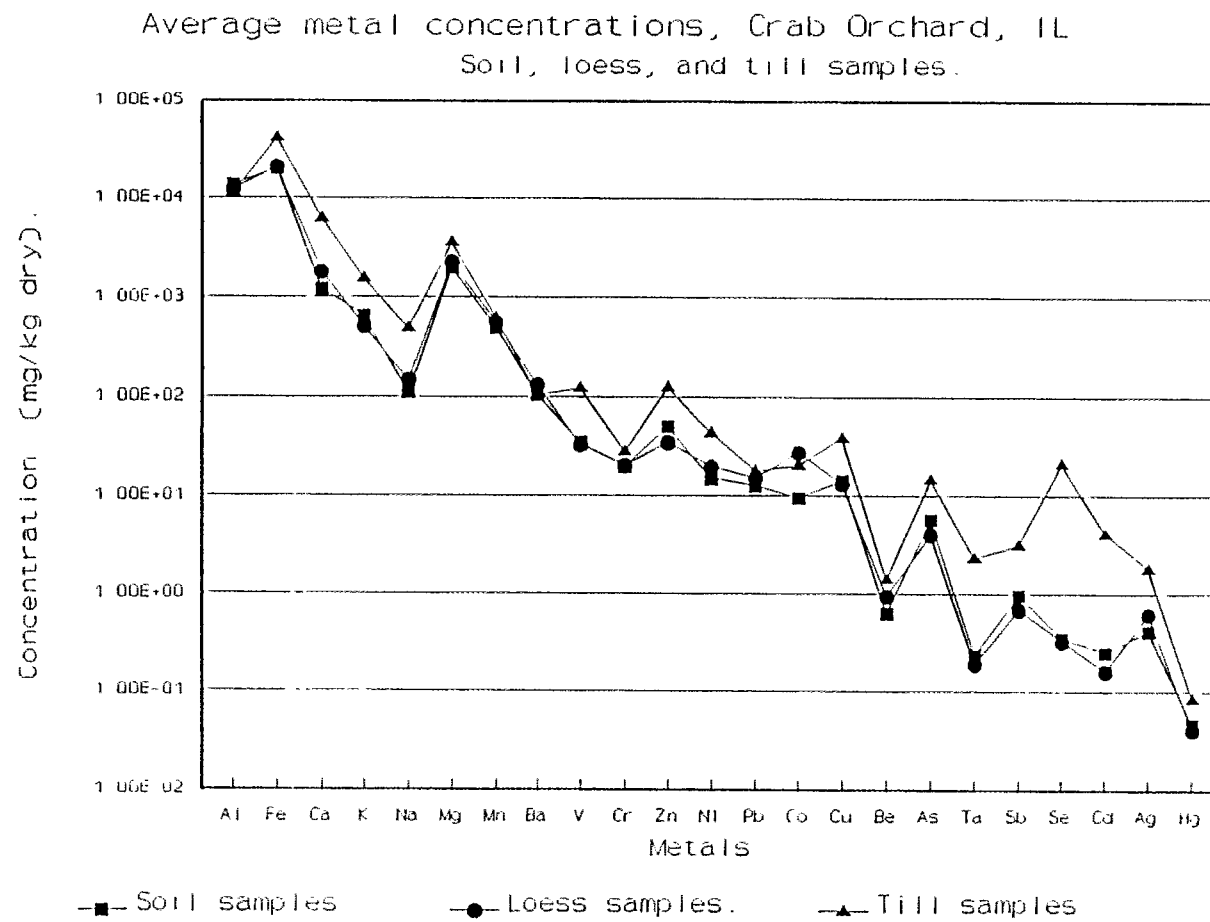


Figure 10.



APPENDIX C

PRELIMINARY RISK-BASED SCREENING CALCULATIONS

CONTENTS

C-1.0 PRELIMINARY RISK-BASED SCREENING	1
C-1.1 SCREENING CALCULATIONS	2
C-1.2 SOIL INGESTION	3
C-1.3 INHALATION OF VOLATILE ORGANIC CONTAMINANTS FROM SOIL GAS	4

APPENDIX C

PRELIMINARY RISK-BASED SCREENING SAMPLE CALCULATIONS

This appendix presents the exposure assumptions and equations used to generate the preliminary risk-based screening tables for preliminary levels of concern. The preliminary risk-based screening tables are presented in Section 5.0. Preliminary risk-based screening is conducted by medium for all contaminants exceeding background, as described in Section 5.0.

C-1.0 PRELIMINARY RISK-BASED SCREENING

All preliminary risk-based benchmark screening concentrations are calculated using residential exposure assumptions consistent with RAGS: Part B (EPA 1991). The calculation of the preliminary risk-based benchmark concentrations considers both noncarcinogenic effects (i.e., systemic toxicity) and carcinogenic effects. Risk-based benchmark concentrations are calculated for concentrations that would be equivalent to exposures at a hazard quotient (HQ) of 0.3 for contaminants with noncarcinogenic effects. A lifetime incremental cancer risk (ICR) of 1E-06 is used for contaminants with carcinogenic effects. Screenings are performed for the ingestion, and volatile organic inhalation pathways.

For carcinogenic contaminants, the general equation to calculate ingestion or inhalation risk-based concentrations is:

$$C = \frac{TR \times BW \times AT \times CF}{SF \times IR \times EF \times ED} \quad C-1$$

where:

C	=	risk-based benchmark concentration on the medium (mg/kg, mg/L, or mg/m ³ for soil, water, or air, respectively)
TR	=	target excess individual lifetime cancer risk (1E-06)
BW	=	body weight (kg)
AT	=	averaging time (365 d/yr x 70 yr)
SF	=	contaminant-specific slope factor (mg/kg-d) ⁻¹
IR	=	intake rate (mg/d, L/d, or m ³ /d for soil, water, or air, respectively)
EF	=	exposure frequency (d/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (as appropriate)

For noncarcinogenic effects, the general equation to calculate risk based screening is:

$$C = \frac{THQ \times RfD \times BW \times AT \times CF}{IR \times EF \times ED}$$

C-2

where:

C	=	risk-based benchmark concentration (mg/kg, mg/L, or mg/m ³ for soil, water, or air, respectively)
THQ	=	target hazard quotient (0.3)
RfD	=	contaminant-specific chronic reference dose (mg/kg-d)
BW	=	body weight (kg)
AT	=	averaging time (365 d/yr x ED in yr)
IR	=	intake rate (mg/d, L/d, or m ³ /d for soil, water, or air, respectively)
EF	=	exposure frequency (d/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (as appropriate)

Risk-based benchmark concentrations are derived using residential exposure assumptions. These assumptions are listed in Table C-1.

C-1.1 SCREENING CALCULATIONS

The following equations provide the screening equations utilized for the evaluation of the soil and the inhalation of volatile contaminants from soil and soil gas exposure routes and reduce the standard default factors to a single factor.

C-1.2 SOIL INGESTION

Carcinogenic

$$C = \frac{TR \times AT \times CF}{SF \times \left[\left(\frac{IR \times EF \times ED}{BW} \right)_{Child} + \left(\frac{IR \times EF \times ED}{BW} \right)_{Adult} \right]}$$

$$C \text{ (mg/kg)} = \frac{(1E-06)(365 \text{ d/yr} \times 70 \text{ yr})(1E+06 \text{ mg/kg})}{SF \text{ (mg/kg-d)}^{-1} \left[\left(\frac{(200 \text{ mg/d})(350 \text{ d/yr})(6 \text{ yr})}{15 \text{ kg}} \right)_{Child} + \left(\frac{(100 \text{ mg/d})(350 \text{ d/yr})(24 \text{ yr})}{70 \text{ kg}} \right)_{Adult} \right]}$$

$$C \text{ (mg/kg)} = \frac{0.64 \text{ d}}{SF \text{ (mg/kg-d)}^{-1}}$$

C-3

Noncarcinogenic

$$C = \frac{THQ \times RfD \times BW \times AT \times CF}{IR \times EF \times ED}$$

$$C \text{ (mg/kg)} = \frac{(0.3)(RfD \text{ mg/kg-d})(365 \text{ d/yr} \times 30 \text{ yr})(1E+06 \text{ mg/kg})}{350 \text{ d/yr} \times \left[\left(\frac{(200 \text{ mg/d} \times 6 \text{ yr})}{15 \text{ kg}} \right)_{Child} + \left(\frac{(100 \text{ mg/d} \times 24 \text{ yr})}{70 \text{ kg}} \right)_{Adult} \right]}$$

C-4

$$C \text{ (mg/kg)} = RfD \text{ (mg/kg-d)} \times 8.2E+04 \text{ d}$$

C-3

C-1.3 INHALATION OF VOLATILE ORGANIC CONTAMINANTS FROM SOIL GAS

Carcinogenic

$$C = \frac{TR \times BW \times AT}{SF \times IR \times EF \times ED}$$

$$C \text{ (mg/m}^3\text{)} = \frac{(1E-06)(70 \text{ kg})(365 \text{ d/yr} \times 70 \text{ yr})}{SF(\text{mg/kg-d})^{-1}(20 \text{ m}^3/\text{d})(350 \text{ d/yr})(30 \text{ yr})} \quad \text{C-12}$$

$$C \text{ (mg/m}^3\text{)} = \frac{(8.5E-06 \text{ kg-d/m}^3)}{SF(\text{mg/kg-d})^{-1}}$$

Noncarcinogenic

$$C = \frac{THQ \times RfD \times BW \times AT}{IR \times EF \times ED}$$

$$C \text{ (mg/m}^3\text{)} = \frac{(0.3)(70 \text{ kg})(365 \text{ d/yr})(30 \text{ yr})(RfD \text{ mg/kg-d})}{(20 \text{ m}^3/\text{d})(350 \text{ d/yr})} \quad \text{C-13}$$

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